

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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No. 5

## CONTENTS

CONFERENCE ON RADIOLOGICAL DEFENSE. INTRODUCTION.	639
MOBILIZATION OF HEALTH RESOURCES FOR DEFENSE.	
<i>W. H. Aufranc, M.D.</i>	641
INJURY FROM ATOMIC BOMBS.	
<i>Brig. Gen. Elbert DeCoursey, M.C., U.S.A.</i>	645
PRELIMINARY SUGGESTIONS FOR ADDITIONAL TEACHING IN RADIOLOGICAL ASPECTS OF ATOMIC DEFENSE.	
<i>Roger A. Harvey, M.D.</i>	653
THE DETECTION OF RADIATION HAZARDS: INSTRUMENTS AND PERSONNEL.	
<i>William F. Bale, Ph.D.</i>	656
THE DIAGNOSIS, PROGNOSIS, AND TREATMENT OF RADIATION INJURIES PRODUCED BY ATOMIC BOMBS.	
<i>Comdr. Eugene P. Cronkite, M.C., U.S.N.</i>	661
RADIOACTIVE DECONTAMINATION.	
<i>Claude R. Schwob, Ph.D.</i>	670
EVALUATION OF RADIOLOGIC HAZARDS AND THERAPY OF RADIATION ILLNESS.	
<i>Capt. C. F. Behrens, M.C., U.S.N.</i>	675
EXCRETORY UROGRAPHY: A CLINICAL TRIAL OF A NEW CONTRAST MEDIUM (SODIUM 3-ACETYLAMINO-2,4,6-TRIODOBENZOATE).	
<i>Laurence L. Robbins, M.D., Fletcher H. Colby, M.D., J. Leland Sosman, M.D., and William R. Eyler, M.D.</i>	684
PULMONARY ARTERY THROMBOSIS: ROENTGEN MANIFESTATIONS.	
<i>Joseph Hanelin, M.D., and William R. Eyler, M.D.</i>	689
CARDIAC MENSURATION AS APPLIED TO SURVEY FILMS (4 X 5-INCH PHOTO-ROENTGENOGRAMS).	
<i>Lewis G. Jacobs, M.D., and Herman Nussbaum, M.D.</i>	704
SOLITARY PULMONARY NECROSIS. A COMPARISON OF NEOPLASTIC AND INFLAMMATORY CONDITIONS.	
<i>Russell Wigh, M.D., and Frederick R. Gilmore, M.D.</i>	708
RADIUM THERAPY OF CARCINOMA OF THE CERVIX UTERI. A METHOD OF DOSIMETRY AFFORDING A COMPLETE DESCRIPTION OF PHYSICAL FACTORS.	
<i>E. S. Kerekes, M.D., and I. Meschan, M.D.</i>	719
CALCIFICATION IN ADRENAL NEOPLASMS. REPORT OF A CASE.	
<i>C. L. Boice, M.D., and W. Norman Sears, M.D.</i>	731
PANTOPAQUE PULMONARY EMBOLISM DURING MYELOGRAPHY.	
<i>Howard L. Steinbach, M.D., and Walter B. Hill, M.D.</i>	735
A PORTABLE CASSETTE CHANGER FOR ANGIOGRAPHY.	
<i>George J. Baron, M.D.</i>	739
EDITORIALS: ATOMIC BOMB DEFENSE.	
<i>R. R. Newell, M.D.</i>	742
PRESIDENTIAL ADDRESS. CONFERENCE OF TEACHERS OF CLINICAL RADIOLOGY.	
<i>C. Edgar Virden, M.D.</i>	743
ANNOUNCEMENTS AND BOOK REVIEWS.	746
RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES.	750
ABSTRACTS OF CURRENT LITERATURE.	753

# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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## Radiologic Defense

THE EIGHTEENTH Annual Conference of Teachers of Clinical Radiology, held in Chicago on Feb. 10, 1951, was devoted to the problems of radiologic defense. Because of the importance of the subject, RADIOLOGY is devoting a large part of this issue to the papers presented at the Conference.

The program was arranged in large part by Dr. Robert R. Newell, Chairman of the Commission on Radiological Units, Standards, and Protection, of the American College of Radiology, and Dr. John D. Camp, Chairman of the Commission on Education. In the enforced absence of Dr. Newell on account of illness, Dr. Camp presided at both the morning and afternoon sessions of the Conference. His opening remarks furnish the best possible background for the papers which follow:

\* \* \* \* \*

"Mr. President, ladies and gentlemen: This is the Eighteenth Annual Conference of the Teachers of Clinical Radiology. It represents the only meeting of its kind that I know of, in which the teachers or those who are primarily interested in the teaching of a clinical specialty gather together annually to discuss informally their particular problems.

"The conference this year, as our program indicates, will be devoted to radiologic defense.

"In June, 1950, the Board of Chancellors of the American College of Radiology was keenly aware of the value of this trained group of men, the members of the College

of Radiology, and their position in the problem of atomic disaster defense. For that reason it felt that we should make every effort to alert our members and educate them to their responsibilities in the civilian defense program—in other words, to train them to assist in the training of others for a job we hope will never have to be done.

"The program relating to radiologic defense which the College has undertaken to carry out may be divided into four parts. The first relates to co-operation with the national, state, and local civil defense programs. In this connection we urge that you offer your services as a radiologist to your state or local defense group without delay.

"The second part is concerned with the education of radiologists, ourselves—medical radiologists, and particularly the teachers of radiology—in the various aspects of radiological protection and defense.

"The third part is the institution of courses of instruction in radiologic defense in our medical schools, hospitals, and kindred agencies, for the education of the staffs, students, and other interested personnel.

"Fourth is the assistance of local civil defense committees in the education of local agencies and the lay public in problems relating to radiologic defense.

"In arranging the Teachers' Conference this year, we have been most fortunate in having the wholehearted co-operation of the various national agencies in Washing-

ton, who have kindly sent their key representatives to participate: Dr. W. H. Aufranc, Acting Director of the Health Resources Office of the National Security Resources Board; Brig. Gen. James P. Cooney, M.C., U.S.A.,<sup>1</sup> Chief, Radiological Branch, Military Application Division, Atomic Energy Commission; Dr. Elbert DeCoursey, Director, Armed Forces Institute of Pathology; Commander Eugene Cronkite, M.C., U.S.N., Naval Medical Research Institute; Dr. William Bale, Biophysics Branch, Division of Biology and Medicine, Atomic Energy Commission;

Dr. Claude R. Schwob, Chief of the Chemistry Branch, U. S. Naval Radiological Defense Laboratory; Captain C. F. Behrens, M.C., U.S.N., Naval Medical Research Institute.

"We are also to hear from Dr. Roger Harvey, Professor of Radiology at the University of Illinois, who will offer us some preliminary suggestions for additional teaching in the radiologic aspects of atomic defense."

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<sup>1</sup> General Cooney's paper is unfortunately not available for publication at this time.

## Mobilization of Health Resources for Defense<sup>1</sup>

W. H. AUFRANC, M.D.

Health Resources Office  
National Security Resources Board

THIS DISCUSSION of some of the problems involved in mobilization of the health resources of the country for defense will be limited to a few of the many health personnel and health supply problems with which the Health Resources Office of the National Security Resources Board is concerned. The difficulties experienced in World War II with respect to the withdrawal of professional personnel from certain communities, without due consideration for the health and welfare of those communities as they affected the national interest and safety, set the stage, as it were, for the approach that should be made in the future. The critical shortages of certain medical supplies similarly conditioned us for better planning in the medical supply field.

The onset of the Korean difficulties and the subsequent enactment of Public Law 779, an amendment to the Selective Service Act, not only re-emphasized the need for mobilization planning in the health field, but materially pointed up the problems that had to be solved at an early date. In a sense, long-range study and planning had to be combined with some short-range decision and action.

In the long-range planning program, the Health Resources Office of the National Security Resources Board considered problems to be faced in planning for civil defense and in this area of activity compiled the material for the manual "Health Services and Special Weapons Defense," now the functional guide in the health field for the Federal Civil Defense Administration.

Early in 1950, national inventories of physicians and veterinarians were completed by their respective professional organizations. The National Security Re-

sources Board also sponsored and supported a national roster of sanitary engineers, and a national roster of nurses, and recommended support from the National Scientific Register project to aid in the development of a more complete roster of dentists.

During the past year a pilot study of health manpower requirements during a national emergency was started in Pittsburgh, Penna. This project, sponsored and supported by the Resources Board, is under the supervision of the U. S. Public Health Service and is being carried out by the School of Public Health at the University of Pittsburgh, with the co-operation of the state and local medical societies and other professional organizations. Surveys of the physicians in the Pittsburgh area are being made to determine the type of practice and the estimated maximum number of patients that could be taken care of by these physicians during a national emergency. Similar information is being obtained by questionnaire from the hospitals in the same area. In addition, by surveys of the consumers of medical care in the area, information is being obtained as to where people go for their medical services and the proportion of the population at varying distances from the center that seeks care in the center. This latter information is being obtained by a house-to-house survey.

This project is being conducted under the immediate direction of Dr. Antonio Ciocco, Professor of Bio-statistics at the School of Public Health, University of Pittsburgh. Dr. Ciocco had extensive experience with health manpower problems and surveys during the last war. It is believed that this study will establish a sound basis for testing the validity of

<sup>1</sup> Presented at the Eighteenth Annual Conference of the Clinical Teachers of Radiology, Chicago, Feb. 10, 1951.

ratios of physicians to population that were employed during the last war as an index to the number of physicians who could be withdrawn from a community for military services. In addition, it is expected that the study will result in an improved methodology for formulating more realistic estimates for use in the current emergency. The project is scheduled for completion early in 1951.

Another study initiated in 1950 and scheduled for completion during the early part of 1951 is being conducted by the Public Health Service for the purpose of determining the number of positions occupied and the number vacant in state and local health departments throughout the nation. This study will furnish a sounder basis for estimating the minimum health department requirements with relationship to the total health manpower pool.

Other types of manpower studies and analyses are being conducted in the following health areas:

Questionnaires have been devised and sent out to hospitals, and to medical, dental, and public health schools to determine minimum needs for interns, residents, and professional school teaching faculties. This work is scheduled for completion early in 1951.

Further studies on needs for nurses and veterinarians are being conducted through existing government agencies and voluntary organizations, and the results will be made available to the Resources Board as soon as possible to form the basis for recommendations as to future programs needed in a national emergency.

Studies of means of altering professional nursing training and teaching patterns are being conducted with the help of the Public Health Service and the American Nurses Association.

Studies of various means of increasing the number of graduates from medical, dental, nursing, veterinary, and other health professional schools were conducted and are continuing. One of the chief studies relates to financial aid to medical and related professional education.

As a part of plans to minimize health manpower deficits, the Office has encouraged the American National Red Cross to embark on extensive training programs for nurses' aides, home nursing, and first aid. These programs will be started early in 1951.

As a result of the Korean conflict, the problem of the allocation of health manpower soon became a clearer function of the Health Resources Office and the Health Resources Advisory Committee of the National Security Resources Board. The Health Resources Advisory Committee was established in August 1950, and in October was appointed by the President to be the National Advisory Committee on the Selection of Physicians, Dentists and Allied Specialists. In this latter capacity, the Committee advises the Selective Service System. In December, the Committee also was delegated two major responsibilities with relationship to reserve officers—physicians, dentists, and veterinarians. According to an agreement with the Department of Defense, the Committee became responsible for: (1) a review of quotas for calling up reserve officers and the making of recommendations to the Secretary of Defense as to the actual need for such officers, (2) giving advice to the Armed Services concerning the actual call up of specific reserve officers under these quotas, by the state and local Selective Service Advisory Committees. The Health Resources Office is responsible for assisting the Health Resources Advisory Committee, particularly in the first of these two functions.

In the field of health supplies, a number of activities have been in process. A survey of the industry was made to determine potential production problems. This project was started in 1949 and initially completed in 1950. Representatives of industry have met on several occasions, either individually or with representatives of the Munitions Board, Chemicals Division of the Materials Office, and the Production Office of the Resources Board. Since the advent of the Korean battle, con-

tinuous revisions in the original surveys have been maintained in order to keep this information current with changing circumstances.

Problems in the area of biologicals have been reviewed and, since the advent of the Korean episode, are being currently revised, in the same manner as described for the drug and medicinal chemical industry. Government agencies assisting in this endeavor have been the Public Health Service, the Bureau of Animal Industry, and the Food and Drug Administration, as well as the Munitions Board.

A survey of the average inventories of surgical supplies carried by the retail surgical trade was completed—with the cooperation of the Department of Commerce—during the year 1950. This material was published under the title "Surgical Instruments and Equipment" and was widely distributed to the surgical trade and to official and non-official agencies and organizations of consumers of these items.

Studies have also been carried out on the system of distribution of health supplies in order to ascertain any inherent weaknesses that might hinder prompt distribution of these supplies and to plan a system which would overcome existing deficiencies. Most of this work was completed in 1950, but rapidly increasing needs for such supplies have necessitated constant revision. Further study and recommendations relating to dispersion of certain segments of the health supply industry, particularly the surgical and diagnostic instrument electronic devices and dental equipment, are necessary in view of the fact that these industries are highly concentrated in areas vulnerable to enemy attack.

Activities in the nation-wide blood program were also undertaken. Late in 1949 the Health Resources Office took the initiative in trying to co-ordinate the efforts of the various interested groups with blood-collecting facilities. Representatives of the Public Health Service, the Office of Medical Services of the Office of the Secretary of Defense, Muni-

tions Board, Atomic Energy Commission, Veterans Administration, Food and Drug Administration, American Medical Association, American Hospital Association, and the American Association of Blood Banks were called to meet with the Health Resources Office. This meeting initiated a series of meetings sponsored by various groups from these agencies and organizations, and a co-operative agreement among them was reached. The importance of bringing these groups together cannot be over-emphasized, because without co-ordination of their efforts a satisfactory nation-wide blood program would be virtually impossible. As a result of the agreement, the National Security Resources Board requested the American National Red Cross to co-ordinate the civil defense blood program with the Department of Defense blood program, and this responsibility was accepted by the Red Cross officials. Throughout the year the Office has worked closely with these various agencies and organizations, particularly the Committee on Policies and Procedures of the American National Red Cross Blood Program, to develop a sound and adequate blood program on a nation-wide scale.

Late in the year it became apparent that, as a result of the Korean battle and the increased tempo of mobilization, neither collection of blood nor facilities for processing blood into plasma could be adequate to meet all national needs. It was apparent that co-ordinated nation-wide plans for increasing blood collection and for increasing plasma production facilities were urgently needed and that some system of allocation of plasma between the Armed Services and civil defense stores would eventually be required. The entire matter has been repeatedly reviewed with representatives of the Bureau of the Budget and of the Medical Department of the Department of Defense, the Munitions Board, the Armed Forces Medical Procurement Agency, Public Health Service, and Civil Defense. The Health Resources Office subsequently has assumed leadership



in attempting to devise satisfactory methods for an equitable distribution of plasma among the three most important claimants, the Armed Services, civil defense, and normal civilian needs. It is hoped that initial plans will be completed early in 1951, but constant revision and surveillance will be required. This is particularly true in view of the fact that blood plasma substitutes are now being thoroughly studied and it is expected that within the near future several of them may obtain wide acceptance. In turn, this will demand revision of plasma requirements and possibly allocations of the various plasma substitutes.

Existing information in the Public Health Service, Department of Defense, Veterans Administration, and Bureau of the Budget has yielded adequate information as to hospital and related health facility resources. Estimates of needs during a national emergency are available from the same sources. Studies of non-professional manpower needs for such institutions have been initiated through the Public Health Service, in order to furnish the Manpower Office with information on essential needs for maintenance of governmental and non-governmental hospitals.

After the establishment of the National Production Authority, the Health Resources Office urged the immediate appointment of a claimant agency for civilian hospital construction and for civilian health

supplies. This was accomplished, with the Federal Security Agency being named the claimant agency for hospital construction and for health supplies other than those in the veterinary field, for which the Bureau of Animal Industry, Department of Agriculture, was named the claimant agency. The Office has made available to these agencies any studies, records, and advice which they have requested in the development of an organization to carry out these claimant functions.

The above rather general statements summarize in some measure the efforts being directed toward the proper mobilization of the health resources for defense as being conducted by the Health Resources Office of the National Security Resources Board and the Health Resources Advisory Committee. There are many inherent problems in this rather unprecedented method of meeting the needs of our over-all defense, but the Health Resources Office has had the fullest co-operation of all official and non-official agencies concerned. At the present time there is every indication that this type of co-operation will continue to the end that the nation will be able to make the greatest possible use of its valuable health resources in a mobilized economy.

Health Resources Office  
National Security Resources Board  
Washington 25, D.C.

#### SUMARIO

##### Movilización de los Recursos Sanitarios para Fines de Defensa

Sumarizanse aquí algunos de los problemas encontrados en la movilización de los medios sanitarios—personal y materiales—de los Estados Unidos para fines de defensa, que han sido considerados por la Oficina de Recursos Sanitarios del Consejo Nacional de Recursos para Seguridad. Comprenden los mismos, entre otras cosas: inventarios nacionales de médicos, dentistas, veterinarios y otros técnicos sanitarios; un estudio de los requisitos en

personal sanitario; encuestas para determinar los problemas de producción potencial de drogas, tanto químicas cuanto biológicas; inventarios de artículos quirúrgicos; estudios de la distribución de equipos sanitarios; y un plan coordinado para aumentar la colecta de sangre y reparto equitativo de la misma entre los Servicios Armados, los organismos de defensa pasiva y las necesidades normales de la población civil.

## Injury from Atomic Bombs<sup>1</sup>

BRIG. GEN. ELBERT DeCOURSEY, M.C., U.S.A.<sup>2</sup>

THE EFFECTS OF atomic bomb explosions on large numbers of human beings have been seen only in Japan. Test detonations of such bombs have allowed studies of physical data and of the biologic reactions of animals other than man. The ionizing radiation injury, although unique in weapons effects, is transcendent not from numbers of casualties or amount of destruction produced, but from the fear it inspires and a certain mystery which surrounds it, encouraging both vocal and written over-emphasis. Only effects of a high air detonation of a Nagasaki type atomic bomb at about 2,000 feet above ground are discussed. It must be remembered that the fireball formed by the explosion rises fast, and thus by the function of distance its effects on the earth-surface are quickly reduced. The tremendous number of casualties produced in a very short time is a most important consideration.

In this paper the characteristics of sources of injury, agents of injury, and types of injury will be considered. The best material for study was collected by the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan (1). Many facets of the investigation have already been presented by LeRoy (2) and by Liebow, Warren, and DeCoursey (3). With this background, observations on experimental animals, both in the field (4) and in the laboratory, may be integrated.

The pattern of injury inflicted on human beings is the product of three main forces released by fission in the bomb: mechanical (air) blast, thermal radiation, and nuclear (ionizing) radiation. The heat of the fireball formed by the detonation expands the air to make a blast wave. The thermal radiations from the hot materials, mostly

infra-red with a mixture of a small amount of ultraviolet rays, comprise about one-third of the total energy released by the bomb. The nuclear radiations originate from fission of the atomic nuclei, and their effects are ionizing, not incendiary.

### AIR BLAST

Mechanical air blast is best explained as an effect like that of a high explosion bomb or a "block buster." The air blast initiated by an atomic bomb is probably not of sufficient intensity to tear human tissues 1,000 feet away, and its pressure is so much more prolonged than that from a TNT blast that the tissues have time to become accommodated to the slower change from positive to negative pressures. The shock wave travels with the speed of sound; it loses its destructive force after about 2 miles, even though windows may be broken 10 or more miles away. Almost complete destruction of buildings within a radius of 1/3 mile, severe damage within 1 mile, moderate damage within 1-1/2 miles, and partial damage within 2 miles are anticipated. As the blast displaces materials, such as portions of buildings, trees, and rocks, flying debris is the chief hazard. Brick facings, marble and plaster interior finishing, and window-panes are transformed into particularly dangerous missiles. Reinforced concrete walls without plaster or any other facing offer the best protection from flying debris. Areas behind hills, or in sharp depressions in the earth's surface, may be entirely free from destructive shock.

Injury from the air blast of the atomic bomb is almost entirely indirect or secondary. There is practically no evidence of primary blast effect as a cause of lesions in the Japanese; even the incidence of rup-

<sup>1</sup> Presented at the Eighteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Ill., Feb. 10, 1951.

<sup>2</sup> Director, Armed Forces Institute of Pathology, Washington, D. C.



Fig. 1. Destruction from air blast. (Neg. NH 123, Armed Forces Institute of Pathology.)

tured ear drums was not increased. Portions of dislodged timbers, overturned vehicles, or shattered buildings may crush and pin down those in the area of destruction (Fig. 1). The force of the blast may

pick up an individual and make of him a secondary missile. The trauma, which is the secondary blast effect, may be delivered to any area of the body and be of all degrees of severity from scratches to com-

plete crushing. Flying debris is the cause of injury in about two-thirds of the casualties. The percentage of deaths caused by wounds alone depends greatly on the overall fire conditions. Air blast itself may be the cause of numerous secondary fires from broken gas lines, displaced furnaces, and the scattering of fire by other means. Flame burns from such fires are discussed in the following section.



Fig. 2. Thermal radiation burn on the exposed surface of fruit. (Neg. HE 139, Armed Forces Institute of Pathology.)

#### THERMAL RADIATION

Thermal radiations are unidirectional and can be compared roughly with rays from the sun, but the intensity of the flash received is much greater because of the proximity of the earth to the bomb. The temperature at ground zero is estimated at 3,000 to 4,000° C. This temperature decreases rapidly with the square of the distance to a limit of practical effect of about 2-1/4 miles (2 CAL/cm<sup>2</sup> equals slight skin burn). According to physicists, the thermal energy is received mainly in that period from 0.3 to 3.0 seconds following detonation; however, unscorched shadows of waving grass (Fig. 4) and skin protected from flash burn by the shadow of a



Fig. 3. Depigmentation of thermal radiation burn of face and neck. Sharp line of demarcation from normal skin that was protected by loose thin clothing. (Neg. NP 117B, Armed Forces Institute of Pathology.)

moving arm cast doubt on a duration of practical effect as long as 3 seconds.

Flash burns from thermal radiation appear only on the surface exposed to the radiation source, as shown on oranges growing on a Nagasaki hillside (Fig. 2). The same phenomenon was observed on the skin as an early erythema which became pigmented ("the mask of Hiroshima") in persons located near the periphery, and sometimes depigmented (Fig. 3) in those who were closer to the source. This loss of pigment was not a result of cell death. Sharp demarcation characterizes radiation flash burns as opposed to flash burns from hot air enveloping the body. Second and third degree burns are sustained by those in progressively closer proximity to ground zero until charring becomes the rule.

Shielding is an important factor because it may determine the extent of a flash burn. Shadows of grass, which probably had withered quickly, were seen on a wood

bunker about 800 yards from zero at Nagasaki. Although the unshielded wood was charred to a depth of 1/4 inch, the shadow stood out unscorched (Fig. 4). Even a deep burn may be sharply delimited by the screening effect of some wearing apparel. The protection of light-colored, loose clothing is superior to that of dark, tight clothing because of the differentially increased absorption of heat by dark colors and the transmission of the effect as a burn to adjacent skin.

be that as many as 50 per cent of all deaths are caused by burns.

#### NUCLEAR RADIATION

The nuclear radiations of greatest biologic importance are the gamma rays which originate chiefly from the fission products in the fireball. These fission products have half lives varying from microseconds to thousands of years; therefore as seconds and minutes pass, the dosage of radiation falls tremendously. Meanwhile, the fireball

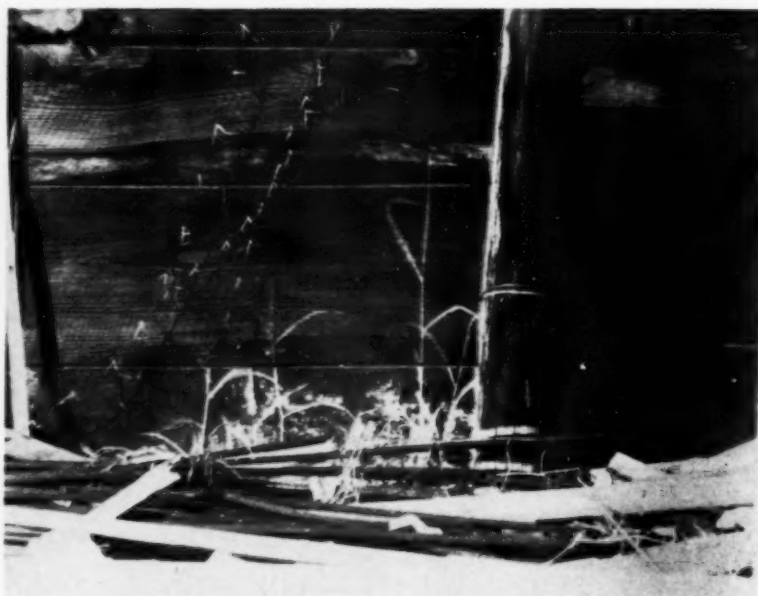


Fig. 4. Phantom grass. Vine with its black shadows from sunlight at left. Wood boards burned black except where shadowed by grass. Wire on post above its unscorched shadow shifted by air blast arriving at speed of sound. (Neg. 4019, Brooke General Hospital, U. S. Army.)

Incineration by flames may be the lot of many who are pinned down by debris or who for other reasons cannot escape from the area before the chimney effect of the rising atomic cloud pulls fires from the periphery to the center, sometimes to result in a fire storm. Flame burns may be the consequence of local blast effects and may be of all degrees of severity without any correlation with distance from the bomb, as in flash burns. The thousands of flash burns and flame burns would seem to cause more than half of the casualties. It may

rise at an average speed of 10,000 feet per minute, thus lengthening the distance from source to ground, with consequent reduction of ground dosage (by inverse square law and absorption in air). The radiation continues for about ninety seconds, approximately 15 per cent being delivered in the first 0.1 second after detonation, 50 per cent by the end of one second, and 80 per cent in ten seconds. Beyond the limits of a 2-mile radius of such a bomb burst, dosage is less than 1 r; at a distance of 4,000 feet, 400 to 500 r are delivered, and



at ground zero (about 2,000 feet), more than 10,000 r. The nuclear radiation can be reduced by filtration, the thickness of the filtering materials being determined by their densities. At a distance of 2,250 feet from ground zero, about 20 inches of earth, 12 inches of concrete, 4 inches of iron, or 2 inches of lead would reduce the dosage below 400 r.

Neutrons that reach the earth from a high air explosion are over 99 per cent "prompt neutrons," originating at the time of detonation and being delivered to the earth surface within 1 second. I am not aware of reliable data concerning their lethal range, but a distance of about 2,250 feet from the ground zero would seem to be the lethal limit by a safety factor of 5; therefore, neutrons would not present an additional hazard. Induced residual radiation seems to be of only academic importance.

Alpha and beta particles have such short range that they do not reach the earth immediately. They may be present in the "fall-out" of fission products from the cloud. As sources of injury within a few miles of the explosion, these particles are of no practical importance.

#### NUCLEAR RADIATION INJURY

The *pathology* of local radiation injury of various tissues has long been known (5). Whether the radiation is alpha, beta, gamma, or x-ray, biologically the injury is qualitatively similar. Total-body radiation of various dosages is delivered to exposed individuals when an atomic bomb explodes. In total-body irradiation, the more sensitive tissues throughout the body sustain the injury, a circumstance allowing the total body to withstand far less dosage than a localized area. The LD 50 for man is thought to be about 400 r total-body radiation. Shielding of a part of the body results in less than total body irradiation and, depending on the degree of sensitivity of the part shielded, increases the resistance of the individual.

As animals differ in their susceptibility to ionizing radiation, as shown in Table I,

TABLE I: MEDIAN LETHAL ACUTE RADIATION DOSE

Subject	LD 50
Ameba.....	100,000 r
Snail.....	20,000 r
Rabbit.....	750 r
Rat.....	650 r
Mouse.....	500 r
Man.....	400 r
Goat.....	350 r
Dog.....	300 r
Guinea-pig.....	250 r

so do various cellular systems of the individual. The most radiosensitive are the lymphocytic, granulocytic, and erythrocytic cells; the more immature, the more sensitive. Then come certain gland cells of the intestine, testes and ovaries, and skin adnexal epithelium, particularly of the hair follicles. The remaining radioresponsive and radioresistant cells of the body showed little, if any, change in the Japanese. Fortunately the basic primitive reticulo-endothelial cells that give rise to the blasts of blood cell systems are quite resistant. After total-body irradiation the ability of these primitive cells to regenerate is the mainstay of life.

The *reticulo-endothelial system*, concerned with the manufacture and delivery of blood cells to the blood stream, sustained damage which is clearly reflected in the blood counts. All of the recorded white blood counts I could find for the first and second weeks following the bombings in Hiroshima and Nagasaki appear in Table II. These are too few on which to build

TABLE II: LEUKOCYTE COUNTS: IRRADIATED JAPANESE

Time after Bombing	Number of Patients	Leukocyte Count
Second day	2	1,670-2,200
Third day	8	200-1,000*
Sixth day	2	400-1,440
Seventh day	17	150-920†
Second week	13	25-740‡

\* Another, 1,600.

† Three above 1,000.

‡ Another, 1,700.

precise dogma, but there is no doubt of the presence of profound leukopenia. High total counts with early absolute lymphopenia would be expected in the first week. Autopsy material from fatalities of the first week shows tremendous atrophy of

the bone marrow, few nucleated cells being present in normally active areas. In the first two weeks there is evidence of reticulum-cell proliferation and of the formation of plasmacytic cells. In the third week islands of regeneration begin to appear; they present mainly reticulum-cell hyperplasia and atypical large cells, and later steadily increasing numbers of plasmacytes (up to 22 per cent) and lymphocytes (20 to 50 per cent). During the first six weeks, the total nucleated cell counts are reduced from 100,000 to less than 10,000. By the fifth week some larger islands give evidence of granulocytic regeneration, and in the sixth week a few show diffuse rather than focal proliferation of granulocytic elements. Even with tremendous myeloid hyperplasia, involving also long bones like the femur, the peripheral blood may still present marked leukopenia, for there is maturation arrest in the bone marrow. In those who will survive, delivery of mature granulocytes from the marrow to the blood stream now begins and reaches normal about the ninth week.

The *lymph nodes* early lose most of their lymphocytes. Atypical cells are formed in attempts at regeneration, which is progressive until about the twelfth week, when the nodes appear normal.

The *spleen* has a similar sensitivity. Loss of most of the lymphoid cells of the splenic follicles and cords causes an early decrease in its size. Here, also, attempts at restoration bring out poorly formed, bizarre cells that sometimes are indistinguishable from Reed-Sternberg cells. Peripheral lymphocytes are typically restored to the normal number about the twelfth week.

Secondary to this reticulo-endothelial-hematopoietic-lymphopoietic breakdown, and perhaps to other unknown factors of blood coagulation and body resistance, petechiae or purpura appear in all portions of the body. They are prominent on the skin about the third week, in the oropharynx about the fourth and fifth weeks, on body cavity and lining surfaces from the second through the sixth weeks, and are present less frequently in

other tissues. Hemorrhages from primary air blast are not expected. Bacterial invasion of tissues is excessive, resulting in extensive neutropenic necrosis (with hemorrhages) of the oral region, in enteritis and pneumonia, all with little inflammatory cell reaction.

Primary radiation injury of deep glandular epithelium, along with the secondary hemorrhagic and infectious processes, leads to a focal, then a diffuse, diphtheritic membranous picture in the *gastro-intestinal tract*. Decreased absorption of foods helps to bring about the cachexia that develops in most patients dying after the sixth week.

In the *testes* the seminiferous tubules lose almost all identifiable spermatogonia and their descendants, so that almost all males dying as a result of high radiation dosage are apparently sterile.

The primordial ova of the *ovaries* present surprisingly little change, but developing follicles are almost absent. The resting endometrium reflects the ovarian inactivity.

Epilation is the gross lesion of the *skin*, the hair follicles being atrophic and some of the sebaceous glands injured. There is no evidence of the usual ionizing radiation skin changes, such as erythema or pigmentation, unless the mention of bullae in a few cases may be so regarded.

*Clinically*, nausea and vomiting may appear on the day of the bombing and may be followed by fever and diarrhea. Epilation is observed during the second week or later. Hemorrhages in skin or mucous membranes and blood in body excretions are other prominent signs. Lymphopenia is severe and immediate. The patients are easily divided into four clinicopathologic groups based on the severity of manifestations of radiation effects, as shown in Table III. The fever is likely to ascend stepwise day by day, particularly in the group classified as "very severe." The tempo at which the symptoms appear and progress has much prognostic significance. For example, nausea and vomiting in the "very severe" group often appeared within half

TABLE III: RELATION OF MORTALITY, TIME OF DEATH, DISTANCE FROM EXPLOSION, AND CLINICAL MANIFESTATIONS OF PATIENTS WITH NUCLEAR RADIATION INJURY

	Clinical Classification			
	Very Severe	Severe	Moderately Severe	Mild
Nausea and vomiting, day of bombing	+++	+++	++	*
Leukopenia	+++	+++	++	+
Purpura	+	+++	++	+
Oropharyngeal lesions	+	+++	+	-
Epilation	=	+++	++	+
Diarrhea	+++	+++	++	*
Fever	+++	+++	++	*
Approximate distance from bomb (meters)	Less than 1,000	1,000	1,000-1,500	More than 1,500
Approximate mortality	100%	50%	Under 10%	None
Time of death (weeks)	1-2	3-6	6-15	

an hour after the explosion, and in the dying members of the "severe" group within three hours; thus, when nausea and vomiting begin within three hours and are actually secondary to radiation injury, the prognosis is extremely grave. Many of the signs and symptoms are those of the aplastic anemia resulting from bone marrow destruction. Emaciation is the rule in those living beyond the sixth week. There are many apparently normal Japanese living today who were temporarily epilated and sterilized by the atomic bombs in Hiroshima and Nagasaki.

#### DISCUSSION

Wounds and burns account for 75 to 85 per cent of the casualties, and ionizing radiation produces 15 to 25 per cent. Laceration from flying debris occurs as far as 12,000 feet from ground zero; burns of one kind or another, as far as 14,000 feet, with flash burns limited to about 9,000 feet and radiation injury to 5,000 feet (the mid-lethal human dose is probably at 4,000 feet, and harmless dosage beyond 7,000 feet). Within 2,100 feet the effects of either air blast or thermal or nuclear radiation are regarded as lethal.

Protection may be made complete if sufficient warning allows one to get into an underground shelter. Even after one sees the flash of explosion there is time for evasive action. Because a second is required to deliver 50 per cent of the gamma radiation, there may be time to perceive the flash and accomplish a dive into a ditch or excavation and thus avoid 50 per

cent or more of the ionizing radiation. Such action also has the effect of removing one from the path of the main air blast traveling at the speed of sound, and if the physicists' calculations for long delivery (three seconds) of thermal radiation prove to be correct, might prevent or decrease flash burns. Animal experiments indicate that shielding of part of the body, particularly the spleen, greatly increases survival rate; therefore special attention to shielding the abdomen would be logical, even to lying on the left side with the spleen further shielded by the right side of the body.

An injured hematopoietic system decreases the body's ability to withstand trauma or burns. The leukopenia or aplastic anemia that may ensue demands the greatest aseptic precautions in handling patients with even moderate wounds or burns, who have been in areas of high dosage. In some experimental animals it has been demonstrated that the added insult of burns reduces the LD 50 dose of ionizing radiation.

The pathologic sequence of events in the bone marrow and lymphoid organs indicates that the reticulo-endothelial system has great powers of regeneration. It seems that if dosage is not too high to prevent regeneration, return to an adequate hematopoietic level can be anticipated in most patients, provided that by some means they can be kept alive during the first eight weeks. Some measure of success with only antibiotic and nutritional approaches seems to be in the realm of probability.

## SUMMARY

Mechanical blast, thermal radiation, and nuclear radiation of a 20 kiloton atomic bomb explosion high in the air, over a large population, result in thousands of casualties from wounds, burns, and ionizing radiation injury. Wounds and/or burns are the cause of over 75 per cent of the casualties.

The radiation injury may be first evidenced clinically by nausea and vomiting on the day of the bombing, or by striking leukopenia. Epilation and purpura may become prominent after the second week. Pathologically, the bone marrow, lymphoid organs, intestinal tract, gonads, and hair follicles show definite lesions, breakdown of the reticulo-endothelial system being paramount. Patients are easily divided into groups presenting clinical, pathologic, mortality and distance correlations.

Lifesaving evasive action is possible even after the flash detonation of an atomic bomb has been detected. Residual or prolonged radiation hazard is not expected from an air burst.

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## SUMARIO

## Lesiones Debidas a las Bombas Atómicas

La explosión mecánica, la radiación térmica y la radiación nuclear ocasionadas por la explosión arriba en el aire de una bomba atómica de 20 toneladas métricas, darán por resultado, en una población grande, miles de accidentes debidos a heridas, quemaduras y lesiones motivadas por la radiación yonizante. Las heridas y/o las quemaduras constituyen la causa de más de 75 por ciento de las bajas.

La lesión irradiatoria puede traducirse primero clínicamente por náuseas y vómitos el día del bombardeo o por intensa leucopenia. La depilación y la púrpura pueden tomar auge después de la segunda semana. Patológicamente, la médula ósea,

los órganos linfoides, el tubo intestinal, los gonados y los folículos pilosos revelan lesiones bien definidas, sobresaliendo la desintegración del aparato reticuloendotelial. Es fácil dividir los enfermos en grupos que presenten correlaciones clínicas, anatomopatológicas, letales y equidistantes.

Puede obtenerse protección total si el aviso da tiempo suficiente para llegar a un refugio subterráneo. Aun después de observarse la detonación centelleante de una bomba atómica, es posible tomar acción evasiva que salve la vida. No hay que temer radiación residual o prolongada tratándose de una explosión aérea.



## Preliminary Suggestions for Additional Teaching in Radiological Aspects of Atomic Defense<sup>1</sup>

ROGER A. HARVEY, M.D.

THE SCIENCE OF Radiology has been vastly increased as a result of developments in atomic warfare. While the primary interest of radiologists is centered in the diagnosis and treatment of disease, they cannot disregard responsibility for prevention of disease due to ionizing radiations. They have learned how to live safely with these radiations and should play an important role in preparing others to deal with these problems.

The immediate problem is to supply undergraduate medical students with sufficient information about "atomic medicine" so that they can conduct themselves intelligently in these matters whether they go into civilian or military practice. This additional background should also stimulate the interest of future medical officers in special radiologic courses offered by the Armed Forces. The basic information should be fairly uniformly given by the different medical schools. Any material which appears to be in addition to that presently covered in assigned hours to radiology should be given by allocation of additional hours. Much of it cannot be taught by radiologists, but they can serve as co-ordinators of the program for their respective institutions.

*Specific Topics to be Covered:* The specific topics to be covered include:

1. The physics and mechanical effects of atomic explosion (Radiology)
2. Self-protection from atomic radiations (Radiology)
3. Decontamination (Radiology, Biochemistry)
4. The nature of radiation damage to tissue and organ systems (Pathology, Radiology, Clinical Medicine)
5. Altered susceptibility to disease following radiation exposure (Radiology, Bacteriology, Immunology, Clinical Medicine)
6. Fundamental aspects of biological, chemical,

and instrument detection of radiation hazard (Radiology, Physiology, Pathology, Biochemistry)

7. Clinical manifestations and treatment of the radiation syndrome (Radiology, Medicine, Surgery, Dermatology, Gynecology)
8. Current status of devices or materials, including consumable chemicals, for radiation protection (Radiology, Biochemistry)

It is assumed that non-radiological aspects of bomb explosion or atomic poisoning will be handled by other departments.

*Methods of Presentation:* Specific teaching of the subjects listed above can be carried out in additional hours of specialized instruction and continuously in nearly every course in a medical school by examples or problems directed to civilian defense or atomic warfare. A minimum of thirty-six hours of additional teaching is indicated to co-ordinate immediately the preclinical aspects of the problem.

The theoretical and mechanical aspects of atom bomb explosion can be given in the first year by means of several movies which are available from the Army Command of the area in which the school is located. A minimum of two or three hours of movies can be supplemented by fifteen to twenty minutes analytical discussion for each hour of film run.

The nature of radiation damage to tissues is primarily the responsibility of the Department of Pathology. Radiation damage should be taught in connection with each tissue and organ and be as much a part of differential diagnosis as infections, neoplasm, etc. A final hour or two should be spent in correlating the radiation damage effects in all the systems.

Bacteriology and Immunology should stress the altered relationship between host and vector, where the former has been weakened by radiation exposure. Anti-

<sup>1</sup> Presented at the Eighteenth Annual Conference of Clinical Teachers of Radiology, Chicago, Feb. 10, 1951. Published also as a part of the Report of the Joint Committee on Medical Education in Time of National Emergency, Association of American Medical Colleges, February 1951.



biotics should be stressed in this respect, and other factors as their promise increases.

Hematology should include material on blood changes resulting from radiation exposure and favorable and unfavorable signs for recovery following treatment.

The detection of radiation hazard is largely the responsibility of the radiologist and his associated physicists. Much material on this subject is already included in existing courses but it could well be amplified by individual instruction. Assigned hours for each student in the X-ray Department will bring out many aspects of radiation detection and protection, provided these hours are not all consumed by our enthusiasm for film demonstration.

The clinical manifestations of the radiation syndrome and their treatment involve a large number of clinical departments. A source of material is the radiation therapy department of any hospital. Ward rounds and amphitheater clinics should include such cases, and their management should be considered in terms of hundreds or thousands of similar situations in the event of an accident. Dermatology, hematology, medicine, surgery, and gynecology would all have important teaching functions.

*Source Materials:* Initial suggested sources of teaching aids include:

1. Selected movies obtainable from Commanding General, Surgeon, . . . Army Command (for your area)
2. Survival under Atomic Attack. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 10 cents
3. Radiological Defense, Volume III, 1950. The Armed Forces Special Weapons Project
4. The Effects of Atomic Weapons (September 1950 revision), Los Alamos Scientific Laboratory. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price \$1.25
5. What You Should Know About the Atomic Bomb. A message from the Surgeon General, 1948. Army Medical Department. R. W. Bliss
6. Medical Aspects of Atomic Weapons. Superintendent of Documents. U. S. Government Printing Office, Washington 25, D. C.
7. What to Do in Atomic Attack, Armed Forces

Talk No. 276. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 5 cents

*Extramural Agencies Which Might Collaborate with a Medical School in Teaching These Subjects Are:*

1. State departments of industrial health
2. Local departments of industrial health
3. Industrial physicians
4. Industrial physicists
5. Visiting lecturers
6. Selected representatives from selected instrument manufacturers
7. Local and state civilian defense specialists
8. Federal agencies

*Films for Radiologic Aspects of Defense:*

*Atomic Energy.* 16 mm., black and white, sound, showing time 11 minutes. Produced in 1947 by Encyclopaedia Britannica Films, Inc., and procurable from them at 207 S. Green St., Chicago, Ill., or from local film libraries. Explains by animated drawings the concepts basic to an understanding of atomic energy.

*Atomic Physics: Part II, Rays from Atoms.* 16 mm., black and white, sound, showing time 11 minutes. Produced in 1947 by Gaumont-British Instructional Films. Procurable from United World Films, Inc., 1445 Park Ave., New York.

*The Effect of Atomic Radiation on Normal Tissue.* Showing time approximately 20 minutes, color. Being produced by Encyclopaedia Britannica Films for the Atomic Energy Commission, Argonne Laboratories. It will review the various types of radiation and highlight the experimental work being done at Argonne on the effect of atomic radiation on normal tissue. Will be released about June 30, 1951.

*Radiological Safety Operation Sandstone (MA-6844).* 16 mm., black and white, sound, showing time 26 minutes. Produced in 1947 by the U. S. Air Force for the Atomic Energy Commission and Armed Forces. Procurable from Bureau of Personnel, Navy Department, Arlington Annex, Washington 25, D. C. A report on radiological safety research and on radiological protection during the Eniwetok atomic bomb blast.

The following films may be procured from the Army Surgeon of the Army Area in which the request originates:

*Atomic Medical Cases: Japan, World War II (PMF 5143).* 16 mm., black and white, sound, showing time 37 minutes. Produced in 1945 by the U. S. Army. A report, taken several weeks after the explosions, of the devastation of Hiroshima and Nagasaki and the damage done to their medical services, hospitals, and inhabitants. The

three types of atomic injury and their pathological aspects are emphasized. Reviewed in J. A. M. A. 142: 51, Jan. 7, 1950.

*The Medical Effects of the Atomic Bomb, Part I: Physics, Physical Destruction, Casualty Effects (PMF 5058).* 16 mm., color, sound, showing time 32 minutes. Produced in 1949 by the U. S. Army. Intended to provide orientation and information on atomic physics, physical destruction, and types of casualties of atomic bombing.

*The Medical Effects of the Atomic Bomb, Part II: Pathology and the Clinical Problem (PMF 5148).* 16 mm., color, sound, showing time 37 minutes. Produced in 1949 by the U. S. Army. The me-

chanical, thermal, and radiation effects of atomic blasts, with a summary and a basis for individual prognosis.

*Radioactivity—Laboratory Demonstrations (PMF 5110).* 16 mm., color, sound, showing time 17 minutes. Produced in 1949. Demonstrates models of the atomic structure and nuclear reaction of a few elements; a dozen instruments for the detection of radioactivity and responses of some of these instruments to a few tracer substances.

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#### SUMARIO

#### Indicaciones Preliminares para Ampliar la Enseñanza de las Fases Radiológicas de la Defensa Antiatómica

Los desenvolvimientos que han tenido lugar en la lucha atómica han ampliado considerablemente la esfera de la radiología. Un problema inmediato consiste en facilitar a los estudiantes de medicina suficiente información acerca de la "medicina atómica," a fin de que actúen inteligentemente in materias de este género.

Los temas específicos que hay que abarcar y los departamentos interesados en la enseñanza de los mismos son los siguientes: (1) física y efectos mecánicos de la explosión atómica (Radiología); (2) protección propia contra las radiaciones atómicas (Radiología); (3) decontaminación (Radiología, Bioquímica); (4) naturaleza de las lesiones irradiatorias en los tejidos y aparatos (Anatomía Patológica, Radiología, Clínica Médica); (5) alteraciones de la susceptibilidad a la enfermedad después de la exposición a la irradiación (Radiología, Bacteriología, Inmunología, Clínica Mé-

dica); (6) aspectos fundamentales del descubrimiento biológico, químico e instrumental de los riesgos irradiatorios (Radiología, Fisiología, Anatomía Patológica, Bioquímica); (7) manifestaciones clínicas y tratamiento del síndrome irradiatorio (Radiología, Medicina, Cirugía, Dermatología, Ginecología); (8) estado actual de los artefactos o sustancias, incluso productos químicos consumibles, destinados a proteger contra la radiación (Radiología, Bioquímica).

La enseñanza específica de esos temas puede llevarse a cabo en horas adicionales de clases especializadas y continuamente en casi todos los cursos de una facultad de medicina por medio de ejemplos o problemas relacionados con la defensa pasiva (civil) o la lucha atómica.

A la par que se bosquejan métodos de exposición, se ofrece una lista de referencias para consulta.

# The Detection of Radiation Hazards: Instruments and Personnel<sup>1</sup>

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WHEN PENETRATING radiation and radioactivity may be associated with weapons used against our civilian populations, radiologists are looked to as experts who will assist in the evaluation of any hazards that may exist and advise on methods and procedures for avoiding or minimizing such hazards. It is important, therefore, that on the one hand they are able and do warn against dangers associated with high-level radioactive contamination, but that, on the other hand, they can and will give prompt reassurance concerning the trivial or tolerable nature of radioactivity that may seem large to the uninitiated but is, in fact, negligible or bearable in amount.

It should be emphasized that an air burst of an atom bomb, the most likely type because it will create the most material damage and loss of life, will almost certainly have associated with it no residual radioactivity that can in any way interfere with the greatest possible effort in the way of salvaging life and valuable property. Elaborate and widespread monitoring operations that impede or delay rescue or treatment of attack victims are entirely superfluous and to be avoided under these conditions. It will be as important a function for radiologists to point out when monitoring need not be carried out in any fashion that will hinder rescue operations or postpone necessary treatment as it will be to see that essential operations are carried out, with as little harm to individuals as possible, under conditions where substantial radiological hazards exist. The development of instruments for civilian defense, as well as the training of personnel for radiological safety and monitoring duties, must take into account not only detection and appraisal of radiological hazards but the equally important duty of

giving assurance if such hazards are in actual fact minimal or unimportant.

## INSTRUMENTS FOR SURVEY OF GAMMA RAY INTENSITIES

The type of instrument of first importance in any radiological defense program is one for measuring gamma ray intensities. This is because the amount of residual gamma radiation present is the primary factor in determining whether an area is safe for habitation or whether it should be evacuated. Beta radiation, because of its non-penetrating nature, can very largely be avoided by remaining indoors and taking other suitable precautions. The amount of gamma radiation received by individuals can also be substantially reduced, but not to nearly the same extent, by staying within buildings, perhaps in cellars; in any event as far from heavily contaminated roofs and walls as possible.

Very little disagreement exists as to the ideal characteristics of a gamma survey meter. It should be foolproof and easy to read. It should accurately measure radiation intensities from a few milliroentgens to some 600 r per hour, the low ranges being particularly useful for training purposes. It should be small in physical dimensions, light in weight, and low in cost, both in terms of money and of critically skilled labor and materials required in its construction. Unfortunately, no instrument at present available has all of these desirable attributes ideally combined in one package. Thus, there remains room for difference of opinion and debate as to which instrument, currently available or in process of design, is the most acceptable for civilian defense survey purposes.

It should be emphasized that most instruments now in use in Atomic Energy Commission laboratories and production

<sup>1</sup> Presented at the Eighteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Feb. 10, 1951.

plants, as well as in other installations, as, for example, hospitals where radioactive isotopes are used, are entirely unsuited to civilian defense use for gamma-ray monitoring primarily because they can measure only intensities so low as to become really hazardous only after days, weeks, or months of exposure. This is true particularly of instruments of the Geiger-Müller counter type at present available commercially, which usually do not exceed 20 milliroentgens per hour at the highest range, roughly one three-thousandth of the top range that a good defense instrument should have. It should be pointed out that this is not an inherent fault in Geiger-Müller counters. Instruments of this type under development or in the pilot-model stage may be well suited to civilian defense use.

These low-range instruments should only be used for civilian defense training purposes, with great caution to ensure that radiological safety people do not obtain false concepts of the intensity of radiation necessary to constitute an acute hazard. The point is that a large region near a bomb detonation may become mildly radioactive. The monitor's function is to differentiate between such areas and regions where acute radiation hazards really exist.

On Dec. 6, 1950, the Federal Civil Defense Administration recommended as the best available and tested gamma ray monitoring instrument for civil defense purposes an ionization chamber type unit with the military type designation AN/PDR-T1. The weight of this instrument (about 11 pounds), the cost (probably \$150.00 in quantity), and the top intensity range of only 50 r per hour, suggested that it would serve largely for interim and training purposes while other instruments were in the development and testing stage. At the same time, specifications were issued for an ideal gamma ray monitoring instrument for civilian defense. It should be noted that certain of these specifications, although desirable, are so mutually exclusive in terms of the present stage of the instru-

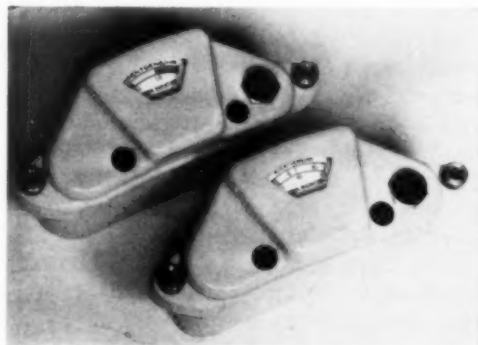


Fig. 1. Civilian type gamma ray monitoring instrument developed by the Health and Safety Branch, New York Operations Office, U. S. Atomic Energy Commission. This instrument uses as its detecting element a halogen-filled G-M tube developed by the U. S. Naval Research Laboratory. Two standard flashlight cells furnish the power supply. Any range up to 500 r per hour can be obtained by using a proper sized G-M tube. Unit cost is estimated at \$25.00 for quantity production.

mentation art that they are to be regarded as goals not all likely to be attained in one instrument with reasonable cost and weight limitations in the near future.

An active program of instrument development for civilian defense purposes, as well as for military use, is under way, supported by federal agencies and by several private concerns. What may perhaps be the first prototype of such a civilian defense instrument suitable for large scale commercial production is illustrated in Figure 1. An account of other developments in this field as of the first of this year is given by Gray and Martens (1).

#### INSTRUMENTS FOR BETA RAY MONITORING

When a mixture of fission products is deposited uniformly on a plain surface, the radiation intensity due to beta rays measured in roentgens equivalent physical (rep) is the order of 100 times the gamma ray intensity. The effect of such beta rays will be largely limited to the skin and they are thus substantially less dangerous than gamma rays in the same roentgen dosage. Also, it is much easier to shield against beta rays while living in a contaminated area. Nevertheless, because of their higher intensity, they are likely to be dangerous during rescue or salvage operation for per-



sonnel working in the open under conditions where whole-body gamma ray exposure is not excessive. The average man is almost as great a national economic loss with badly and permanently injured hands and feet as if he had died from whole-body gamma exposure. Such injury is entirely possible from beta ray exposure. Monitoring beta ray intensities, therefore, will be important in protecting personnel carrying out rescue operations in areas with high degrees of radioactive contamination.

In contrast to the 25 r whole-body gamma irradiation that probably can be received once or twice with almost complete lack of risk, and the 100 r that probably is not incapacitating for gamma rays, the dose of beta radiation that probably will not seriously affect the hands is almost certainly above 500 rep, perhaps above 1,000 rep. Thus, a beta ray monitoring instrument should measure intensities, preferably in rep units, up to levels of several thousand rep per hour.

Beta monitoring and gamma monitoring, ideally perhaps, should be performed by a single instrument. For low-level measurements around laboratories, this is a common combination, and at least one high-range instrument offered commercially for civil defense has a window for admitting beta rays. However, in general, no calibration in terms of beta ray intensities measured in rep is provided by any instrument now available. The gamma ray calibration does not hold for beta rays in most of these instruments, often by factors of several hundred per cent, so that such instruments, unless independently calibrated, provide little information as to the risk involved. Making commercially available an instrument with a suitable range and calibration for beta measurements in civilian defense remains a task yet to be accomplished.

#### INSTRUMENTS FOR MEASURING CONTAMINATION IN FOOD AND WATER

It is probable that levels of beta activity as high as  $2 \times 10^6$  disintegrations per minute of beta-gamma activity can be per-

mitted in water or food, in a ten-day period following an atomic bomb blast, with little risk, and that at levels 25 times lower the risk is insignificant. Risks from associated alpha activity would be negligible compared with beta ray hazard in the first few days following an atomic bomb detonation. Levels of 10,000 plutonium alpha disintegrations per minute per cubic centimeter in water for ten days carry little hazard.

Fortunately, these levels of beta activity lie nicely in the range of the present type of portable Geiger-Müller counters now used for laboratory monitoring. Therefore, these widely distributed instruments, relatively useless for other types of monitoring, can fulfill a real use in this connection. Measurements can be simply made by placing water or food in a shallow dish and bringing the counter, with window open to admit beta rays, close to the surface. Work is now under way in one Atomic Energy Commission laboratory to provide radioactive standards for such measurements. Any laboratory equipped independently to measure dosage for medical use of radioactive isotopes can also make such standards for calibrating portable instruments, basing calibration on the assumption that the fission product beta spectrum is equivalent to strontium 89.

#### PERSONNEL DOSIMETERS

There are two principal uses for personnel dosimeters.

(a) *Dosimeters for Casualty Segregation Purposes:* It would conceivably be useful in an area a likely target for atomic bomb attack, to provide every inhabitant with a dosimeter, to be kept always on his person, that could easily be read and would indicate the seriousness of the radiation dose to which he had been exposed. Such a segregation type of dosimeter would be particularly useful if a specific treatment for radiation damage is developed that depends for success upon prompt application, even before signs of radiation sickness develop. If the treatment remains essentially that of symptoms as they develop, a general distribution of segregation type



dosimeters seems of considerably less importance.

Dosimeters of this type should be accurate to 100 r or better and cover the range from zero to about 800 r. Almost certainly photographic film type dosimeters of the dental film type are too complicated to develop and read for this purpose. Self-developing units of the Polaroid Land camera type show promise, as do several other types based on fluorescence, color-changing liquids and crystals, print-out photographic badges, and changes in electrical conductivity in liquids.

(b) *Dosimeters for Disaster Relief Workers*: A second type of dosimeter, one for which there exists a very real requirement, is for the use of rescue personnel. This dosimeter, preferably self-reading or read without difficulty by a small, easily carried auxiliary device, is for the protection of rescue workers, that they may not unknowingly receive too high radiation doses in performing their duties. This dosimeter would preferably read to some 200 r, with an accuracy and reproducibility of some 10 per cent of this value. However, if the dosimeter can be readily recharged, a smaller range, down to 25 r, is probably acceptable, since the user can, if necessary, recharge it during relief operations.

Self-reading quartz film instruments of these lower ranges are either available commercially or soon will be. Limitations at present are high cost, \$50.00 each or more, and limited production capacity.

Ideally one versatile instrument might perhaps serve both the functions listed above for a personnel dosimeter. However, such an instrument does not seem to be quite in sight at the present time, although dosimeters based on one or more of the principles mentioned under segregation dosimeters may eventually prove cheap, sensitive, and accurate enough for both purposes.

#### RADIATION DETECTORS FOR WIDE DISTRIBUTION

A real danger probably exists that in the event of war, and particularly an atom bomb detonation, rumors of radioactive contamination would cause a population to flee in panic when actually there was no hazard involved. It has been suggested that in order to alleviate such a possibility, a radiation-detecting device of moderate sensitivity might be widely distributed so that everyone could see for himself whether dangerous amounts of radioactivity existed in his neighborhood.

One such instrument, admirable for simplicity and rugged of construction and ease of use, has been developed by Dr. G. Failla, Professor of Radiology at Columbia University. It consists, in one design, simply of a plastic egg cup filled with about thirty glass or quartz beads some 0.5 mm. in diameter and sealed in dry air by a transparent sheet of polystyrene cemented to the top. Simple shaking produces charges on the beads that cause them to separate and climb up on the inner walls of the plastic vessel. Without radiation it will remain charged for several days. About 1 r causes the beads to fall together at the bottom of the cup. As long as the beads stay apart, rumors of dangerous radiation can safely be disregarded. If the beads fall together and cannot be recharged by shaking, or if recharging is followed by discharge in a few minutes, then it is time to leave the vicinity if it is at all possible. Instruments of this type should cost less than \$1.00 each and could be widely distributed. They do not use critical materials.

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(Para el sumario en español, véase la página siguiente.)

## SUMARIO

**El Descubrimiento de Riesgos Irradiatorios: Instrumentos y Personal**

La elaboración de instrumentos destinados a la defensa pasiva contra los riesgos de la irradiación incidente a la lucha atómica, así como la preparación de personal dedicado a la misión de resguardo y aviso en cuestiones radiológicas, tiene que tomar en cuenta no sólo el descubrimiento de tales riesgos sino también el problema de tranquilizar los ánimos si aquellos son mínimos.

La clase de instrumento que reviste importancia primordial en la defensa radiológica es la que mida las intensidades de los rayos gamma, pues la cantidad de ra-

diación gamma residual constituye el factor primario en la determinación de si una zona dada es o no habitable. El despistaje de intensidades de rayos beta revestirá importancia especial en la protección del personal que lleva a cabo misiones de rescate en zonas muy contaminadas.

A la discusión de los requisitos ideales para aparatos de despistaje, dosímetros para el personal y detectores de radiación para distribución amplia, se agregan descripciones de los instrumentos hoy día obtenibles.



## The Diagnosis, Prognosis, and Treatment of Radiation Injuries Produced by Atomic Bombs<sup>1</sup>

COMDR. EUGENE P. CRONKITE, M.C., U.S.N.<sup>2</sup>

THE PURPOSE OF this paper is the presentation of practical information on the diagnosis, prognosis, and treatment of such radiation injuries as may be seen in atomic warfare. Others have amply covered the physical effects of the atomic bomb. The chaos that will exist in the immediate post-explosion period has been succinctly described. We are all aware that the greatest hazard is panic caused by the overwhelming fear. Progressive education and indoctrination of the public should allay this greatest of hazards in atomic warfare. Providing that there is some semblance of order in the civil population, it seems self-evident that care of the injured should be organized along the general lines of military medical care, i.e., first aid, collection, transportation, evacuation, etc., but under previously organized civil direction not military. The medical problems following an atomic bomb explosion are complex. The immediate problem will be of a magnitude that will seem almost insuperable. It may be necessary in the early period to lower our high standards of care to a practical level that makes it feasible to care for hundreds of thousands of casualties. The after-care will last for months, and it is certain that the salvage rate will be higher if the definitive care is in special centers under the direction of competent specialists. This latter principle should *never be compromised*. It obviously does not apply to the immediate period after the explosion, when the only objective is the rapid first aid and evacuation of those still alive.

Others have emphasized that, percentage-wise, radiation injury is of lesser importance, but 10 per cent of 100,000 casualties still present a frightful problem.

Radiation injury resulting directly or indirectly from the use of atomic weapons

may be divided into two categories: (1) the superficial ionizing radiation burn from soft radiation (beta); (2) total body radiation injury, "the syndrome of acute radiation injury," from penetrating whole body radiation (gamma and neutrons). The radiation burn was not seen in Japan; it is a remote possibility and has been discussed adequately elsewhere (1-4).

In respect to exposure of the whole body to penetrating ionizing radiation there are three important questions to be answered:

1. Was there significant exposure?
2. If exposure occurred, what is the prognosis?
3. If exposure occurred, what is the effect on other injuries?

The answers to these questions may not be easily obtained. Since animal experimentation has clearly demonstrated wide sublethal, lethal, and supralethal ranges, and since radiation intensity diminishes sharply with the distance from the source (the exploding bomb), one can arbitrarily divide an exposed population into three general groups based on likelihood of survival:

*Group One:* Survival from radiation injury is *improbable* (supralethal doses).

*Group Two:* Survival from radiation injury is spontaneously *possible* (the lethal range).

*Group Three:* Survival from radiation injury is *probable* (sublethal radiation injury).

An analysis of the Japanese clinical experience at Hiroshima and Nagasaki, experimental atomic bomb explosions, and laboratory irradiation of large animals demonstrates that there are three approaches to the arbitrary segregation of an exposed population into the three groups defined above:

1. Distance from the explosion.

<sup>1</sup> Presented at the Eighteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Ill., Feb. 10, 1951.

<sup>2</sup> Head of the Hematology Division, Naval Medical Research Institute, Bethesda, Md.

TABLE I: MEAN SURVIVAL TIME AND MORTALITY OF UNTREATED DOGS (15-25 KG.) EXPOSED TO VARYING DOSES OF 2.0 PEAK MEV (MEAN ENERGY 0.54 MEV)

Dose	Number	Mortality	Range	Mean Survival Time	Signs and Symptoms
3,000	12	100	3-4	3.3	Vomiting and diarrhea from irradiation to death
1,000	12	100	3-9	6.6	Vomiting on day of bombing; 2-3 day latent period; anorexia and diarrhea
600	42	100	4-21	12.2	About 50% vomit on day of bombing; 4-10 day latent period
500*	10	100	7-12	9.8	Same as 600
400	10	100	6-19	16.2	No initial symptoms; 6-15 day latent period; then purpura
300	10	20	12-15	13.5	No initial symptoms; 10 day latent period; anorexia; death
200	10	0	...	...	No initial or late symptoms except leukopenia

\* During this experiment distemper appeared in normal dogs in the animal colony. All irradiated 500 r dogs had pneumonia at autopsy.

## 2. Personnel and other dosimeters.

## 3. Symptomatology.

Distance from the bomb may be misleading because of the following factors:

(a) Shielding is not accurately known. (b) Size, height, and type of bomb are not immediately known. (c) Uniform radial distribution cannot be assumed because of interfering terrain and buildings.

Personnel radiation dosimeters will obviously be helpful but are not self-sufficient diagnostically or prognostically because: (a) They may not be independent of energy. (b) The sublethal, lethal, and supralethal ranges for man are not accurately established. (c) The absolute sensitivity of any individual can never be known—some may survive 600 r, some may die with 200 r. (d) The dosimeter may be shielded or exposed.

The dosimeter has been widely publicized. For military purposes, where conditions are rigidly controlled, it may give field commanders very valuable information about numerous replacements that will soon be needed and about numbers of troops that will soon have to be evacuated and numbers that can be relied upon for the next few days. In an undisciplined civil group, it is questionable as to whether an easily read dosimeter will do more psychologic good or harm, since valid assurance on prognosis cannot be made on the basis of absolute exposure. On the other hand, the liberal distribution of dosimeters on lamp posts, telephone poles,

etc., would be helpful in establishing the approximate radii of the minimal lethal dose and the absolute lethal dose.

The symptomatic segregation of a population into groups based on likelihood of survival is not perfect. This approach has the following attributes: (a) The symptoms and the tempo of the illness to probable death were observed in Japan to be related to the probability of survival (5-8). (b) The symptoms as observed in Japan were dependent on broad ranges of dose and were not correlated with a specific dose. (c) No special equipment is needed. The system is based on clinical observation and judgment. (d) Experimental work with large animals is beginning to amplify and verify the Japanese experience.

By and large, it is believed that the simplest approach to the diagnosis and prognosis of radiation injury produced by whole body exposure to penetrating radiation is by analysis of the symptoms. Utilizing the initial symptoms and subsequent clinical behavior as the prognostic and diagnostic guides, one can approximate an accurate division of the population into the general groups previously defined as follows:

*Group I Casualties: Survival Improbable:* Casualties of this group will present the following picture: (a) vomiting immediately or within a few hours; (b) rapid tempo, vomiting continuous and followed by prostration, diarrhea, tenesmus, fever,

and severe dehydration; (c) leukopenia prompt and profound; (d) death within a few days.

The typical blood picture for this type is not available from Japanese data. Perhaps human beings will respond as the goats did at Bikini after exposure to more than 1,000 r atomic bomb radiation (Fig.

relation of dose and survival time. Survival time decreases sharply as the 100 per cent lethal dose is exceeded, remains constant at three to four days over a range of 1,500 to 30,000 r, and beyond 30,000 r again decreases, with mice dying under the beam. Similar observations have been made before (9, 10). Observations of

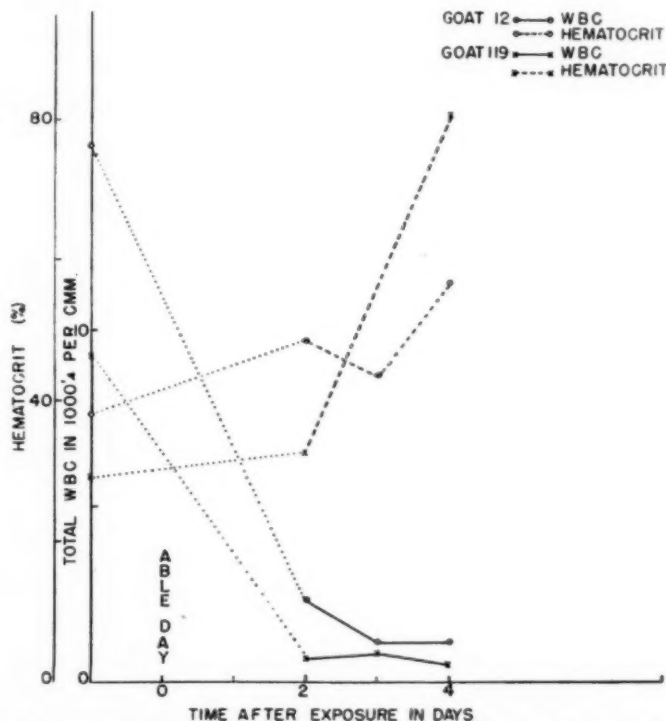


Fig. 1. Hematocrit and leukocyte counts of two goats exposed to approximately 1,000 r total body atomic bomb radiation. Diarrhea, anorexia, and apathy present from first observation to death.

1). Note in particular the severe leukopenia and the marked hemoconcentration, the latter resulting from diarrhea and failure to drink.

The relationships of mean survival time and mortality to dose are of interest and are demonstrated in Figure 2 and Table I, along with the signs and symptoms. It is apparent that, in dogs, absence of vomiting on the day of irradiation does not assure recovery but its occurrence almost certainly assures death. Inspection of Table I and Figure 2 shows a definite cor-

relation of dose and survival time. Survival time decreases sharply as the 100 per cent lethal dose is exceeded, remains constant at three to four days over a range of 1,500 to 30,000 r, and beyond 30,000 r again decreases, with mice dying under the beam. Similar observations have been made before (9, 10). Observations of

human beings exposed to such doses are unlikely unless the base surge with the radioactive aerosol cloud observed in the underwater test at Bikini is duplicated. *Group II Casualties: Survival Possible:* The following picture will be presented by Group II casualties: (a) Vomiting will probably occur on the day of bombing and subside within twenty-four hours. (b) Following the vomiting there will be an asymptomatic period of one to three weeks before recrudescence. (c) The asymptomatic period may be terminated by pur-



pura, epilation, oral and cutaneous lesions, infections of wounds or burns that were otherwise healing well, and bloody diarrhea.

The mortality of this group, without complications and untreated, cannot be forecast with certainty.

cates that the addition of sublethal radiation and thermal burns will produce a high mortality in dogs. If true, this observation will greatly increase the difficulties in the care of atomic bomb casualties.

Emphasis has been placed by many workers on the value of the leukocyte

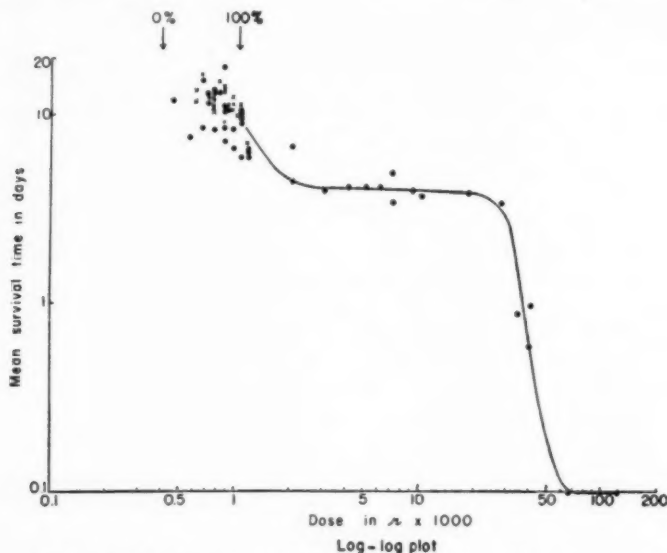


Fig. 2. The mean survival time of white male Swiss mice as a function of dose of total body 2.0-mev x-ray irradiation. In the lethal range 450–1,050 r, mean survival varies from eight to sixteen days. From 1,500–30,000 r mean survival is constant at four to five days. With more than 30,000 r, mice begin to die under the beam. Upon completion of 100,000 r all mice are dead.

The syndrome of vomiting followed by a latent period occurs in dogs that have been exposed to more than a minimal absolute lethal dose (Table I). If this is also characteristic of man, the mortality in Group II may be much greater than 50 per cent.

**Group III Casualties: Survival Probable:** The observations in Group III will differ from those in Groups I and II as follows: (a) There will be no vomiting on the day of bombing. (b) Late symptoms, if any, will be milder but similar to those in Group II. (c) Without late symptoms the effects will be detectable only by (1) serial leukocyte studies, (2) personnel radiation dosimeters, (3) known distance from the bomb. (d) Mortality in uncomplicated cases will be low.

Recent work by Evans *et al.* (11) indi-

count in radiation injury. The Japanese data have been analyzed and carefully presented by LeRoy (7). These are unfortunately incomplete because few serial daily studies were performed by the Japanese, the dose of radiation was not known accurately, and only scattered observations were made in the first ten days. Work on small animals is voluminous and adequate in the high dosage range but adequate serial studies of survivors and non-survivors in the lethal range have not been published. DeBruyn (12) has shown the lymphatic response to be a function of absolute dose and not the LD 50 in various species. There is a growing conviction that the myeloid response follows the LD 50 of the species (13).

In Figure 3, serial studies on dog granu-

locytes are presented for varying doses of radiation. It is of interest that spontaneous survival appears when the granulocyte response is characterized by an undulating course and does not fall much below 1,000 per cubic millimeter.

Detailed hematologic responses have

that there is nothing that one can do about this degree of radiation injury at the present time. Therapy would be directed toward maintenance of fluid and electrolyte balance and control of the vomiting and diarrhea, with the hope of prolonging life until regeneration of radiosensitive tissues be-

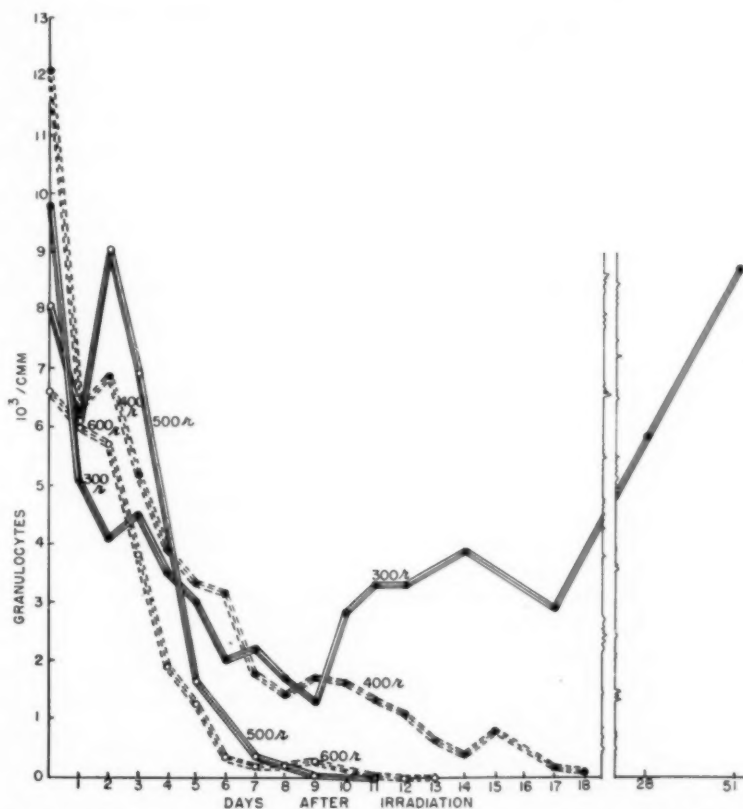


Fig. 3. Mean daily granulocyte counts of dogs exposed to varying lethal doses of 2.0-mev total body x-ray irradiation. Mortality of the doses presented in Table 1.

been published elsewhere (14, 15, 16). Of interest in the present connection are hematologic observations that may have prognostic value. These are given in Table II. None of the hematologic indices of probable recovery or impending death are infallible.

#### TREATMENT

Group I casualties present no major therapeutic problem for the simple reason

gins. If life is prolonged one or two weeks, the problems would become those of Group II. There is no evidence that early transfusion is of value.

It is of great interest that none of the methods of increasing the survival rate of animals by pre-irradiation procedures has been effective with exposures to more than 1,400 r. In dogs the early histologic bowel lesion becomes marked with doses greater than 1,000 r, and at 3,000 r reparative

TABLE II: VALUE OF HEMATOLOGIC OBSERVATION IN DIAGNOSIS AND PROGNOSIS OF RADIATION INJURY FROM EXPOSURE OF THE WHOLE BODY

1. Absolute lymph count 24 hours after exposure, good index of relative exposure in the sublethal range
2. Favorable prognostic signs
  - (a) Return of reticulocytosis and its increase
  - (b) Granulocytes remaining above 1,500 per cu. mm.
  - (c) Return of platelets and failure of platelets to drop below 75,000 per cu. mm.
3. Unfavorable prognostic signs
  - (a) No platelets, no reticulocytes, less than 500 granulocytes 15 days after exposure
  - (b) Purpura with prolonged clotting time
  - (c) Development of fever with any of above is indicative of almost certain death

processes do not appear during the life of the animal (18). Perhaps the bowel lesion with such doses is incompatible with continued life. In addition, there is no evidence of spontaneous regeneration of the bone marrow of the dog with doses in excess of 500 r (2.0 mev).

The major therapeutic problem is the treatment of Group II casualties. Within this group there are four obvious lethal factors listed in Table III. There may be other obscure factors that we do not recognize. For example, will the radiosensitivity of germ-free mammals be greatly altered and in which direction?

The hemorrhagic phase has been variously ascribed to: (1) thrombocytopenia, (2) altered capillary fragility, (3) blood coagulation defect, and (4) circulating anticoagulants. Current studies have shown that all phenomena connected with radiation bleeding can be amply explained by the profound thrombocytopenia. The prolonged clotting time parallels the increasing thrombocytopenia, which is accompanied by a marked defect in prothrombin utilization. In our experience, heparin has not been found, and evidence for non-specific anticoagulants has been sporadic. It is not necessary to introduce the concept of an anticoagulant to explain the hemorrhagic phase. All phenomena can by correlation be explained by the severe thrombocytopenia (20).

Prevention, combating, and reversal of the four lethal factors constitute the therapeutic objectives of Group II casualties.

The susceptibility to infection is explainable on the basis of the granulopenia and impaired immune responses. The infections may be produced by true pathogens but usually are due to invasion by commensal organisms. Prophylaxis raises some difficult problems. If antibiotics are given too soon, the organism may develop resistance to these drugs when they are urgently needed.

There is no good evidence to indicate the optimum time for instituting prophylactic antibiotic therapy. As a suggestion, it is believed that oral administration of

TABLE III: TABULATION OF OBVIOUS LETHAL FACTORS IN GROUP II CASUALTIES (SURVIVAL POSSIBLE)

1. Infection usually from commensal organisms; pathogens, also, if any were initially present  
Factors causing susceptibility
  - (1) Granulopenia
  - (2) Impaired immune responses
  - (3) "Adrenal exhaustion"?
2. Hemorrhage  
Factors causing
  - (1) Thrombocytopenia and its sequelae
    - (a) Increased capillary fragility → petechiae
    - (b) Impaired prothrombin utilization → increased clotting time
    - (c) Poor clot retraction → fragile clot
  - (2) Anticoagulants questionable
  - (3) Infections
    - (a) Ulceration into vessels
    - (b) Precipitates purpura in thrombopenic state
3. Anemia  
Factors causing
  - (1) Failure to produce
  - (2) Increased destruction of red blood cells
  - (3) Hemorrhage
4. Electrolyte, water, acid-base disturbances  
Factors causing
  - (1) Anorexia
  - (2) Diarrhea
  - (3) Fever
  - (4) "Adrenal exhaustion"?

penicillin and aureomycin should be commenced by the beginning of the second week. The development of clinical signs of infection (fever, ulcers, etc.) is a definite indication for the vigorous use of antibiotics orally and parenterally. A wide spectrum of antibiotics will be needed because of the diverse bacteria that may invade. Antibiotics should be continued until granulocytes are in excess of 1,500 per cubic millimeter and until all evidence of infection has subsided. Actual dose schedules for the various antibiotics consistent with availability and stockpiles that may

exist will be formulated by the NSRB and OCD in the future.

Therapy of the hemorrhagic phase is unsatisfactory. Platelets still cannot be satisfactorily replaced by transfusion. The flavones (rutin, etc.) are of questionable value in increasing capillary integrity. Heparinemia can be combated, but there is no evidence that it exists. Antibiotic therapy will minimize ulceration and to a large extent prevent massive fatal hemorrhage by erosion of vessels.

Furthermore, infection tends to precipitate extensive purpura in the pancytopenic animal.

Treatment of the anemia is obviously replacement. When production ceases, there will be a red-cell deficit of approximately 1 per cent per day. If production stops for a month, a 15.0 gm. hemoglobin would drop to approximately 10 gm. The decrease was more rapid than this in the Japanese and in laboratory animals before hemorrhage occurred, indicating that there must also be an increased destruction (21, 22). It is estimated that the average mid-lethal radiation casualty will need 5.0 to 6.0 units of blood for maintenance of red-cell level. To this must be added the amount lost by hemorrhage. Maintenance at a 10-11 gm. average seems sufficient.

Maintenance of electrolyte equilibrium and nutrition during the anorexic and pyrexia phase is extremely important. The parenteral use of glucose, electrolytes, and amino acids is so well known that further comment is not necessary. Proctoclysis may be very helpful. The irradiated dog absorbs fluid per rectum without difficulty (23).

Group III casualties *per se* will present the same therapeutic problem as Group II, but on a lesser scale, unless there are complicating injuries or epidemics develop. This group, however, and the survivors of Group II will constitute the major long-term problem so far as study of the population for latent effects (cataracts, leukemia, cancer, etc.) is concerned. To date, cataracts have been the only problem in Japan, and this on a small scale (19). Genetic

effects, if any, will extend over many generations.

The use of laboratory studies for guidance in therapy is desirable but in general not practical on a mass scale. About all one can expect are the following: (1) determination of hemoglobin and plasma protein by the copper sulfate method; (2) determination of urinary specific gravity; (3) leukocyte counts with chamber differential using a pyocyanol nuclear stain (24).

#### SUMMARY AND CONCLUSIONS

1. The *prognosis* of radiation injury is summarized as follows:

(a) If vomiting occurs on the day of the bombing and is followed by diarrhea, prostration, continued vomiting, anorexia and fever, survival is improbable, and death will occur in a matter of days.

(b) If vomiting occurs on the day of the bombing and is followed by an asymptomatic period of one to three weeks before appearance of the typical symptoms of radiation injury (purpura, epilation, ulcerations of the mucous membranes, and gastro-intestinal disturbances), survival is possible.

(c) If there is no vomiting on the day of the bombing, survival is probable unless there are complicating factors such as burns, thermal injuries, traumatic injuries, or concomitant epidemics. Epidemics in a leukopenic population may be catastrophic.

2. There is no simple answer to the *treatment* of radiation injury. The pancytopenia temporarily induced by potentially lethal amounts of radiation is, from the therapeutic standpoint, essentially no different from idiopathic pancytopenia or that temporarily induced by drugs or infections.

Under ideal conditions, each individual would constitute a separate therapeutic problem in which the course to be followed would be dictated by the good *clinical judgment* of the physician in charge, following well established therapeutic principles for the treatment of pancytopenias in general. There is no obvious reason why the

temporarily induced pancytopenia of radiation injury will not respond to treatment as well as the temporarily drug-induced pancytopenia.

At the present time there is no new drug, hormone, or vitamin which when administered after irradiation will significantly increase the survival rate. However, there is a growing mass of evidence that suggests that it may be possible to increase the survival rate of animals up to about 1,400 r total body exposure by accelerating recovery of hematopoiesis. At this level, survival time becomes shortened and other lethal mechanisms become apparent.

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#### SUMARIO

##### El Diagnóstico, Pronóstico y Tratamiento de las Lesiones Irradiatorias Producidas por las Bombas Atómicas

1. El diagnóstico y el pronóstico de las lesiones irradiatorias aparecen resumizados en la forma siguiente:

(a) Si ocurre vómito el día del bombardeo y va seguido de diarrea, postración, hiperemesis, anorexia y fiebre, la sobrevivencia es improbable, y la muerte sobrevendrá en más o menos días.

(b) Si ocurre vómito el día del bombardeo y va seguido de un período asintomático de una a tres semanas antes de la aparición de

los típicos síntomas de lesión irradiatoria (púrpura, depilación, úlceras de las mucosas, y trastornos intestinales), la sobrevivencia es posible.

(c) Si no hay vómito el día del bombardeo, la sobrevivencia es probable a menos que existan complicaciones, tales como quemaduras, lesiones térmicas, traumatismos o epidemias concomitantes. La aparición de epidemias en una población leucopénica puede resultar catastrófica.



2. El tratamiento de las lesiones irradiatorias no tiene solución sencilla. La pancitopenia temporal evocada por cantidades potencialmente letales de radiación no es, terapéuticamente hablando, distinta, en el fondo, de la evocada temporalmente por drogas o infecciones, o de las formas idiopáticas.

En la actualidad, no hay nueva droga, hormona o vitamina que, administrada

después de la irradiación, acreciente mayor cosa la tasa de sobrevivencia. Sin embargo, se van acumulando datos indicativos de que puede ser posible acrecentar el índice de sobrevivencia de los animales hasta unos 1,400 r de exposición orgánica total acelerando la recuperación de la hematopoyesis. A ese nivel, se acorta el tiempo de sobrevivencia y hacen acto de presencia otros mecanismos letales.



# Radioactive Decontamination<sup>1</sup>

CLAUDE R. SCHWOB, Ph.D.

U. S. Naval Radiological Defense Laboratory

**A**N ATOMIC BOMB, in one sense, may be considered to be a device for efficiently and rapidly producing untold amounts of radiation and radioactive substances. If the radioactive material so produced is spread over an area, that area is said to be contaminated. Once deposited, the material continues to give off harmful rays for a long time, and nothing now known to science can stop this process. This so-called residual radiation is as deadly as the instantaneous radiation: it has been calculated that at the time of deposition on some of the Bikini-Baker target ships, the resulting radioactivity was of the order of 50,000 r per hour.

Not only are surfaces of objects contaminated, but so is dust. The latter is often disturbed during and immediately after a burst and can find its way inside the body. Thus, we have both an external and internal hazard.

I need only refer to the statements of the previous speakers to establish the importance of the problems posed by the residual radiation. Fortunately, even in a full-scale atomic war, contamination can be expected fairly rarely. There are ways of using atomic bombs to give maximum destruction and immediate effects, without contamination. Let us consider this point.

## OCCURRENCE OF CONTAMINATION

First of all, how and under what circumstances can we expect to be faced with contamination? In an air burst, which incidentally is considered the most efficient for destruction, the danger of contamination is so small that it may be neglected. However, underwater, underground, and surface bursts will cause widespread contamination. In such instances, the fission products are trapped by the water or the soil and, instead of being dissipated in the

stratosphere, are returned to the surroundings by the force of gravity.

The contaminants will be deposited on surfaces and any exposed material or equipment. The vagaries of individual situations will determine just how this contamination will be distributed. In general, however, one may cite the following guiding rules:

(a) There will be more contamination on horizontal surfaces than on vertical ones.

(b) There will be more contamination on rough, porous surfaces such as cloth, rope, and concrete, than on smooth hard ones such as glass, plastics, polished metals, and paint.

(c) The greater the amount of contamination on a given surface, the greater the fraction that will be readily removed by simple means.

This last concept requires a bit of amplification. It has been observed that contamination removal becomes increasingly difficult as the removal proceeds. We interpret this to mean that only that part of the contamination which is in immediate contact with the surface is held by strong forces. The remainder of the contamination is, so-to-speak, merely shoveled on, and rather loosely held. Hence, any ordinary cleaning procedure is generally successful in treating it.

The contaminants themselves consist of more than 200 distinct radioactive isotopes of some 33 elementary species. In a bomb burst of the contaminating type, they are all present and are often aided and abetted by other radioactive materials produced in the immediate surroundings of the bomb burst. I daresay that these contaminating substances run the gamut of physical and chemical properties; among them one may find the near extremes of solubility, reactivity, colloidal, and adsorption character-

<sup>1</sup> Presented at the Eighteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Feb. 10, 1951.

istics. After working with them for a while, one is convinced that all possible behaviors occur—all save those that might make the decontamination job easier.

Subsequent to an atomic explosion of the contaminating type, radioactivity is distributed over a wide area, of the order of 4 square miles or more. The radiation emitted is harmful to man, and the area is thereby rendered "tabu." Once an area is heavily contaminated, personnel cannot survive—much less work—in it unless they are shielded (a cumbersome and impractical method for general use), or until the radioactive materials are removed, or until the radiation has died down or decayed to an extent permitting limited operation in the area.

#### EFFECT OF TIME

This latter is a very important point. It is both a curse and a blessing that in the interval shortly after the burst, the radiation decays in a very rapid manner. Twelve minutes after deposition, the activity will be reduced to 10 per cent of its initial value; seventeen hours after, only one one-thousandth of the initial activity will be left; in turn, a drop to one ten-thousandth of the original value occurs in four and one-half days.

The "blessing" aspect of the rapidity of the decay is apparent: let us just sit tight and wait for the nature of the beast to do our work for us; let us give the radioactivity time to commit suicide.

The medal has another face—a tarnished one. The "curse" lies in the fact that the very rapidity of the decay leads inexorably to high radiation fields: one is proportional to the other. Hence, anyone caught in the field is exposed to a high radiation level, up to 50,000 r per hour for the first few minutes, as I have already stated. Anyone exposed to such a field, even momentarily, is of course a casualty. This is one of the sad facts about contamination, one of the very few facts, fortunately, for which no answer has as yet been devised or foreseen.

Buildings will give varying degrees of protection to their occupants. This is

being worked out. At present all I can say is that, in an extremity, any protection is worth taking advantage of. It seems certain that interior, low-level rooms of solid modern structures will provide an adequate degree of protection from the radiation. Similarly, makeshift deep trenches or foxholes may prove useful. Those fortunate enough to be so protected should remain in their shelters for two to four hours to permit the radioactivity to die down to the extent that, in a quick dash to uncontaminated regions, "safe" total exposure will not be exceeded. In this sense, and in this sense only, can I say that the strategy is "evacuate and wait" or, more precisely, "wait, evacuate, and wait some more."

#### WHEN TO DECONTAMINATE

There are instances where decontamination must be done rapidly. These are limited for the most part, however, to the military: a ship at sea, an aerodrome, a beach-head. At the present state of the art, it can be emphasized that, for civil defense purposes, a waiting period is advisable, feasible, and effective.

Once the radioactivity has decreased to a point permitting a certain degree of freedom in the affected area, however, decontamination is necessary to restore the area to complete use. Otherwise, we would be requiring people to work and live in close proximity to a danger. All painted surfaces exfoliate to a certain extent; normal wear transforms part of flooring surfaces to dust at every step; repair, reconstruction, and ordinary industrial operations raise contaminated dust and fumes. For real safety, a thorough, if leisurely, decontamination job is required.

#### GENERAL PRINCIPLES OF DECONTAMINATION

The term "cleaning" has often been applied to decontamination. I, for one, am not happy about this use. Granted, decontamination is a super cleaning-up job—that is the *aim*. The nature of the "dirt" to be removed, however, requires technics that are much more refined than denoted

by the word "cleaning." First, the hazard must be considered: the external radiation hazard to a certain extent; the possibility of introducing the noxious material into the body, to a dominating extent. Secondly, we must remember that decontamination at best consists in the *transfer* of the radioactive material from an undesirable location to another where it can be tolerated. There is no neutralization of radioactivity: nothing that we poor mortals can do will influence the radioactive process in any way. Being "bad actors," the radioactive atoms must be segregated: we do not know how to kill them. Hence, we must consider the problem of waste disposal. In fact, the first step in any decontamination operation is to plan for the disposal of the products of the process.

With these limitations in mind, we can now broadly consider the field of decontamination. As I have mentioned before, part of the contaminating radioactivity is very tenaciously held by surfaces. We have two paths open to us: (1) to remove the material without harming the surface itself, or (2) to remove the outer layers of the surface, thereby simultaneously removing the radioactivity. Both approaches are applicable, both have proved successful at our laboratory, the U. S. Naval Radiological Defense Laboratory at Hunters Point in San Francisco.

Luckily, the greater fraction of surfaces we have to deal with are rugged, tough, and perfectly adapted to drastic treatment. Sandblasting in the presence of water or vacuum blasting constitutes one answer. Flame priming is another, particularly adapted to concrete and wood surfaces. Purely abrasive methods are also effective provided proper precautions are taken—as with *all* methods. The surface may be partially or wholly removed by the use of chemicals, too. Paint removers are effective, especially lye and trisodium phosphate. The chlorinated-hydrocarbon type paint-removers are less effective due to the fact that the radioactivity has a tendency to relocate itself on the newly exposed sur-

face when they are used. Strong acids have an eroding action that is very useful and effective on certain surfaces: rust, calciferous scale, metals, and concrete. An extreme case of surface removal is exemplified by the use of strippable protective coatings. Tarpaulins, even newspapers, can be used as disposable covers. In a limited number of cases, it might prove advisable to protect equipment, objects, and even whole buildings with the so-called stripcoats, paint-like materials that can be peeled off quite readily.

When it is required that the surface not be harmed, or if specialized equipment suitable for the use of the foregoing methods is not available, various cleaning agents have been proved useful. Certain detergents, especially selected built-up ones similar, and in instances identical, to some of the common household soapless cleaners, are very efficient in removing contamination. When used hot, as in the so-called steam-cleaning methods, their action is rapid and effective. We have measured removal factors as high as a thousand in a few minutes. Complexing agents, too, are useful. Citric acid is the old stand-by for such uses. Its limited availability in very large quantities is, of course, a deterrent. Fortunately, readily available materials such as ethylenediamine tetraacetic acid (sold under various trade names such as "versene" or "sequestrene") and the triphosphates are as good, sometimes better.

#### SPECIFIC EXAMPLES

Let us now consider some specific problems. An interesting surface to worry about is our own. Clothing may be considered to be a disposable covering. The outer garments, if contaminated, are removed. Exposed skin is washed with soap, or better yet, a detergent. A complete shower, if available, is desirable. Should this procedure not be effective to the desired extent, chemical solutions will remove the remaining activity. It is moot whether complexing agents can be recommended. Experiments at Hunters Point have demon-



strated that complexing agents are likely to increase the rate of diffusion of fission products through the skin, transforming an external hazard partly into an internal hazard. The research has not progressed sufficiently to permit evaluation of the relative hazard presented by the surface contamination and that produced by the absorption of a fraction of the contaminant through the skin. Mild depilatories, such as weak hydrochloric acid ( $pH$  1.5), will remove most residual contamination, apparently by a removal of a superficial layer of the skin. Other depilatories, containing sulfur compounds, are equally effective, but are considered more irritating to the skin than weak acid. Mucous tissue had best be treated with isotonic sodium bicarbonate. We are not ready to recommend anything else.

Next, let us consider food and water. Food in sealed compartments, such as refrigerators, may be considered absolutely safe provided no physical damage is evident. Similarly, packaged foods are protected, provided the covering is intact and that the container is decontaminated before it is opened, and that only to the extent that no more contamination can be rubbed off.

Certain other food items which are ordinarily peeled before use, such as potatoes, can be used with precaution. Agricultural foodstuffs contaminated in the growing state in the fields present a peculiar problem, and it would probably be necessary to analyze them to decide their fitness for consumption, each instance being treated as a problem in itself.

As for water, I am not too worried. Reservoirs are far from primary target areas; the volume of water is tremendous; ordinary purification systems are effective in removing radioactive materials, as is adsorption on the walls of the water mains. I do not believe that seepage through the ground will constitute a hazard, since experiments have demonstrated that the adsorptive and ion-exchange properties of soil cause foreign ions to concentrate at the surface. In fact, I believe that a well

can be dug in a contaminated area to yield radiologically safe water.

Large-area contamination is a problem calling for much engineering skill and hard work for its solution. For the decontamination of soil, we now know of no better method than either to scrape a layer of the soil with bulldozers or to plow under the upper layer. Roads may well be treated by ordinary street cleaning methods: large vacuum cleaners in use in some cities, supplemented by hosing with water or detergents, will aid in decontaminating hard-surfaced roadways.

#### PROTECTIVE MEASURES

I have so far assumed that the radioactive debris of the bomb will reach surfaces and contaminate them. An intriguing line of speculation lies in means of preventing the contamination from either reaching the surface or sticking to the surface.

Short of preventing the detonation of a bomb, we must accept the dissemination of radioactive debris. At Hunters Point, experiments have shown that a stream of water flowing over a surface will act as an effective deterrent to contamination, reducing it quite significantly. In addition, experiments directed toward the development of surfaces of minimum contaminability or maximum decontaminability, or both, are under way, with promise of at least partial success.

#### RADIOLOGICAL WARFARE

Is the bomb the only source of large-scale contamination? Much comment has been aroused by the possibility of disseminating radioactive agents over targets in order to deny their use to the enemy. Such a use of radioactivity is known as radiological warfare. Ordinary high-explosive bombs, or cloud-dispersing planes, might conceivably be used. To be effective, tremendous amounts of radioactivity must be used: of the order of one megacurie per square mile. The production of such incredibly large quantities of radioactivity is a major problem, and would divert neutrons from atom bomb production. How-

ever, we cannot neglect the possibility of the use of such weapons.

Radiological warfare involves several factors not considered in the discussion of bomb contamination. Perforce, the materials employed must have a half-life long enough to permit stockpiling and delivery. They will thus exhibit a decay rate much less rapid than the early decay rate of atom bomb debris. Because of this and because of limited quantities, the initial level of radiation will be much less, perhaps 200 r per day. In such a field, decontamination operations can be performed by crews working twenty to thirty minutes at a time. It is expected that the usual decontamination methods will be adequate.

#### CONCLUSION

It has been possible here merely to outline the problem and to give you some of the answers we have been able to reach. There remains much work to be done, but one thing is clear: We are faced with a major problem, yes, but it is not insoluble, and when analyzed is not as great in its

effects as panicky first thought indicated. Frankly, I believe it never will be licked. We can, however, accomplish much in making intolerable contamination tolerable.

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The concepts used in this discussion are based largely on data found in *The Effects of Atomic Weapons* (Government Printing Office, 1950). Particular attention is called to:

- (a) Charts for determining total radiation exposure in a contaminated area, pages 319 and 398
- (b) Chapter XII: Protection of Personnel
- (c) Chapter X: Decontamination

In addition, data on decontamination of laboratory surfaces may be found in:

- TOMPKINS, P. C., BIZZELL, O. M., AND WATSON, C. D.: Practical Aspects of Surface Decontamination. *Nucleonics* 7: 42, August, 1950.
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#### SUMARIO

##### Decontaminación Radioactiva

Si las materias radioactivas producidas por una bomba atómica se esparcen por una zona, dícese que ésta se halla contaminada. En una explosión aérea, el peligro de dicha contaminación es menospreciable. En cambio, las explosiones submarinas, subterráneas y superficiales sí ocasionarán contaminación difusa, abarcando una zona de 10 km.<sup>2</sup> o más. Las sustancias contaminantes comprenden más de 200 distintos isótopos radioactivos de unas 33 especies elementales, y la radioactividad durante los primeros cuatro minutos podría ser del género de 50,000 r por hora. Eso disminuye rápidamente debido a la veloz desintegración, pero se necesita decontaminación para restablecer el pleno uso de la zona.

Como no se conoce ningún método para neutralizar la radioactividad, la operación

viene a convertirse en la eliminación de los productos del procedimiento, lo cual exige alejamiento bien de las sustancias contaminantes o de las capas externas de las superficies contaminadas. Para lo primero, han resultado útiles varios limpiadores, y en particular ciertos detergentes, sobre todo si se usan en caliente, y agentes complejos, como el ácido cítrico. Para el tratamiento de las superficies, menciónanse el raspado con arena en presencia de agua, el raspado al vacío, el flameo y técnicas puramente abrasivas. Los quitapinturas también surten efecto, e igualmente los ácidos fuertes, tratándose de herrumbre, escamas calcíferas, metales y hormigón.

Considéranse también problemas específicos de decontaminación del personal y del alimento y el agua, agregándose una breve reseña de la guerra radiológica.

## Evaluation of Radiologic Hazards and Therapy of Radiation Illness<sup>1</sup>

CAPT. C. F. BEHRENS, M.C., U.S.N.

EVALUATION OF radiologic hazards would ordinarily comprise many phases. In view of the professional status of this group, however, and the urgent possibilities of the time, it is appropriate to limit this dissertation to the more unfamiliar problem of the larger total body dosages and what we call "calculated risk."

These newer categories of radiological hazards relate to single or occasional exposures of considerable degree, or again to unusual exposure over limited periods of time ranging from a day to a few months, rather than to the more continuous exposure of people continually employed in the various fields of radiology. These newer categories also involve more stern and inescapable necessities. Thus the permissible limit of 0.3 r per week, devised to take care of customary working risks over long periods, has only a very limited application to this type of problem. The situation is more or less the same as the case of clinical radiology, where different standards apply and we consider first of all practical therapeutic necessity. For instance, in therapy we often and knowingly administer amounts of radiation that involve some damage to normal structures.

In wartime evaluation of radiation hazards, we must be as realistic as in the case of other perils. Under naval and military necessity we must accept risks from bullets, explosives, fire, and what not, through the whole category of injurious agents, including disease. We must do the same with radiation hazards.

### IMMEDIATE CONSIDERATIONS AND MORALE FACTORS

In the case of acute necessity, the major thought must be for effectiveness of personnel during the action. We can say

that, no matter what the dose of ionizing radiation, a group of men will not be mowed down as by bullets and will surely be able to carry on for a short time. If, however, dosage approaching or exceeding 200 r is received in the space of minutes or less than an hour, effectiveness of personnel concerned will be seriously impaired in a matter of hours. This may well have a disproportionately adverse effect on morale because of mental hazards associated with radiation. These are about as follows:

(a) *Fears of Sterility and Impotence:* Apprehension as to sterility and impotence is often absurd and exaggerated and points to the need for persistent educational efforts because these fears strike very deep levels and are not easily eradicated.

(b) *Aura of Mystery and Dread:* The stage has been well set to give all the uninitiated an overdose of these morale shakers, and this calls for educational effort to keep the imagination from running riot and at the same time to retain a wholesome respect for actual hazards.

(c) *Impact of the Bizarre and Severe Pattern of Serious Radiation Illness:* This is a practical consideration when numerous casualties are involved and is aggravated by the interim of relative well-being during which victims may scatter and so produce widespread demoralizing effects when symptoms develop. It points up the need of keeping track of potential radiation casualties and also employment of the most adequate dosimetry possible.

(d) *Effects of Suggestion:* There is wide variation in susceptibility to radiation symptoms, but when a few of a group begin to exhibit these, the tendency will be for quite a few more to follow suit. Encouragement, distraction, and prompt disposal of mild cases are worth consideration here,

<sup>1</sup> Presented at the Eighteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Feb. 10, 1951. The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

apart from relieving an outfit so affected as soon as possible.

The incidence of even mild symptoms is apt at present to occasion undue alarm and the itch to get out of the affected area at once. An important consideration here is the preliminary indoctrination. If there is a realization that such symptoms do not necessarily mean a serious or fatal outcome, it will be easier to handle the situation. This involves consideration of dosimetry. If one can say to his subordinates that they are not receiving fatal or notably injurious amounts of radiation, it should prove most helpful. To leave them in a state of uncertainty would probably be demoralizing once symptoms began to appear. This indicates the need, at least for those exercising command, to have accurate information.

#### DELAYED ACUTE EFFECTS

Following the immediate effects of radiation received in a single brief or so-called "acute" exposure, there is usually a variable period of comparative well-being, following which delayed effects are apt to come on and produce considerable numbers of very serious radiation casualties if the exposure approaches or exceeds the 200 r zone. This type of illness would also be in part dependent on the extraneous factors of work, effort, and fatigue, and also exposure to cold, heat, and wet. Delayed effects tend to come on in the second week and would be along the lines of the Japanese casualties. Such effects relate to malaise, lassitude, gastro-intestinal symptoms, low blood counts, diarrhea, hemorrhages, anemia, and infection. Thus, the following considerations apply in the event of such acute exposure:

(1) Most of those exposed would be incapacitated and require hospital care within a period of a few days to a few weeks.

(2) Heavy physical effort during any interval of comparative well-being would be distinctly harmful.

(3) Increased susceptibility to infectious diseases would be probable.

(4) The course of other injuries would be complicated and aggravated.

#### REMOTE EFFECTS

Remote effects are related to total exposure and are relevant not only to single acute exposures but also to repeated exposures to dosages below those associated with obvious acute clinical effects. Such cumulative dosage may reach high figures without obvious effects. The matter sums up about as follows:

(1) Effects are proportionate to dosage and to a lesser extent to dosage rate.

(2) Nearly all survivors of radiation illness are in good condition.

(3) Increased rate of aging may be involved. This is apt to be negligible except for quite large totals (500 to 1,000 r), which would ordinarily prove fatal in acute dosage.

(4) Increased incidence of leukemia (about ten times in radiologists—number of radiologists involved very small; actual risk extremely slight).

(5) Carcinogenic effects are not well evaluated and in general slight. Local effects, as from alpha emitters or beta-emitting fission products, are more important here.

(6) Increased incidence of cataract (60 to 80 in Japan; a few in this country from neutron exposure) is not important.

(7) Possible increase in dental caries is suggested by recent work (200 r) at NMRI, Bethesda, Md. This is not important.

(8) Increased likelihood of transmitting unfavorable genetic mutations is not of general significance unless a large proportion of the population receives heavy dosage. It can, however, be of great individual importance to families affected. (Quantitative calculations derived from very uncertain extrapolations suggest that this increase might approximate 1 per cent for 100 r.)

(9) Depending on dosage and dosage rate, there may or may not be sterility. If this results, it is apt to be temporary in males; less apt in females. (A dose of 400



to 700 r to the gonads within a period of a month or so is usually required.)

(10) Impotence is not involved. This is seen only as a temporary phase, when general weakness and illness severely deplete the body, or as the result of psychic disturbance.

(11) Female members of the Armed Forces who might possibly be involved (Waves, Wacs, or nurses) might show menstrual disturbances for a considerable period and there might be instances of permanent amenorrhea. (Dose of 300 to 700 r received within a period of several months.)

#### MEDICOLEGAL COMPLICATIONS

Medicolegal complications would largely derive from the remote effects noted above and the natural tendency to blame all ills on anything connected with previous service or occupation. An important consideration is that good records of exposure should be maintained so that the possible relation of subsequent ills to exposure while in the service can be properly evaluated, and thus insure a fair deal to the individual and also protect the employer from unwarranted claims.

#### NOTES ON REPEATED "CALCULATED RISK" EXPOSURES

The foregoing gives some account of the problem of acute exposures, but there remain problems relating to repeated exposures to amounts below the usual symptomatic threshold.

Experimental studies indicate that, if doses of 10 to 50 r are given daily or every few days until death results, the lethal dose is raised several-fold, even in occasional instances ten-fold. That poses the question as to how far we can go in that regard.

As indicated by clinical experience with cancer cases in which generalized radiation has been employed, daily or thrice weekly doses of from 10 to 50 r can be given without serious effects on the general health. However, there are deterrents to consider. When as much as 50 r is received several

times weekly, there is likely to be some general malaise, anorexia and nausea, and perhaps headache. A high level of performance could hardly be depended on from personnel so exposed. Again, as total dosage mounts to substantial figures, say over 200 r, we may expect a serious falling off in endurance and performance, lessened resistance to infection and trauma, and poor psychological adjustment. We must remind ourselves to think in terms of individuals who are or may be called upon for supreme performances rather than in terms of patients who, while receiving such dosages, are under careful medical and nursing care and in general can take it easy under optimal environmental conditions.

#### PRACTICAL RECOMMENDATIONS ON CALCULATED RISK

Recommendations about as follows seem fairly reasonable for rapidly accumulated or so-called "acute dosage."

(1) Avoid calculated risk exposures whenever possible. This is worth serious planning and effort.

(2) Give careful consideration to possible use of shielding and protective garments; also prophylactic measures.

(3) Consider 25 r as the ordinary limit within which no trouble need be anticipated, even though there may be some question of occasional mild effects.

(4) Consider the 50 r zone as a level at which a few people are likely to have minor symptoms.

(5) Consider 100 r as the zone at which grave concern should begin. There will be casualties, increasing reduction in effectiveness, and serious morale problems as this level is exceeded.

(6) The 200 r zone spells serious radiation illness to all concerned, and occasional fatalities. When a dose of this magnitude is received in smaller increments, close observation is needed, since general effects on performance and health may occur.

(7) Acute dosages over 200 r involve rapid onset of incapacity and increasing mortality. Voluntary incurrence of such

exposure would be a measure of desperation. The 400 r dose approximates the LD 50, and a 600 r exposure would almost always prove fatal.

(8) Finally, it should be remembered that the correlations between effects and dosages, as mentioned above, are rough approximations. Effects vary enormously depending on the type and energy of radiation. Furthermore, under actual operating conditions exposure may not be uniform. There are great individual variations in susceptibility. It thus becomes necessary, in passing a verdict on the personnel risks involved in any particular situation, to take into consideration all monitoring data that can be obtained, as well as dosage rate, along with information as to the type of duty and effort involved and likelihood of exposure to extremes of weather.

#### COMPENSATORY TIME AWAY FROM RADIATION EXPOSURES

The usual standards for permissible doses are based on 0.3 r maximum in a week, the idea being that if a person received that much on a single occasion he should avoid exposure for the next week. This provision has a reasonable basis in the fact that spreading out the dosage of a noxious agent is always advisable. It has been noted that the amount of radiation needed for lethal effects is much less for a single exposure than when relatively small daily doses are employed. Recovery or replacement activities are given time to operate and irreversible changes reduced.

It is possible that in the service and in disaster emergencies, similar and even greater dosages may become inevitable and so involve the principle of compensatory time out. A few notes are offered bearing upon this problem.

Exposures may often be minimized by advance planning and by arranging for a rotation schedule.

Compensatory time out should be arranged as soon as practicable, and for exposures near or over the 25 r zone should preferably be longer than the time given by mathematical application of the

0.3 r standard. No data presently available indicate how much this should be, but a purely personal guess is that we should be quite liberal and ordinarily double it. I would be inclined to advise no further or very limited occupational exposure for those who have received 200 r or more within a brief period.

#### DOSIMETRY

When dosimetry becomes a consideration in connection with use of atomic weapons, there will probably be monitoring groups or individuals available to collect data for evaluation of situations and as a guide to action. Our main concern as radiologists and physicians in this phase would be evaluation rather than direct or technical supervision of the monitoring. We should become familiar, however, with the general types and principles of operation. Active research is still in progress and there are various types of Geiger counters and ionization instruments; scintillation or phosphor models are also coming into use.

Of particular concern to us is personnel dosimetry, and it might be noted that in the Navy the Medical Department is charged with the responsibility for photodosimetry.

Personnel dosimetry is accomplished at present chiefly by film badges and pocket dosimeters. These are designed largely to measure the low doses concerned in usual occupational exposure. We find them in constant use in Atomic Energy Commission installations. Several years ago we prepared for photodosimetry in the Navy in view of possible wartime responsibilities, and also in part to stimulate general regard for radiological safety. The start was made by inclusion of the subject in the course of training of our x-ray technicians. As soon as practicable, this was followed up by requiring the use of photodosimetry in naval hospitals and later arranging for it in our industrial establishments wherever x-rays or radium are used. Thus, we now have a number of people scattered throughout the naval service who have experience in the work. It is possibly more important in the naval service than in others, since we are

more apt to be concerned with subsurface bursts and radiological contamination. As a matter of fact, we were actually concerned with this problem for a long while after Test Baker. Universal employment of photodosimetry is scarcely requisite, but in view of possibilities it might be well to encourage certain hospitals in appropriate locations to conduct photodosimetry.

As mentioned already, the customary range of film badges is quite low (0.05 to 1.0 r) and so not well adapted to the possibilities of atomic warfare. More suitable emulsions are available for this purpose and research still goes on. At present the duPont 605 will cover a range of 10 to 200 r with ordinary x-ray developer, and 100 to 2,000 r with Reprodol developer. The duPont Adlux film will cover a range of 10 to 1,000 r with x-ray developer and is perhaps the most suitable at present. There will soon be available, also, a high-range film packet provided with pods containing processing chemicals, so that an approximate reading can be obtained without delay.

Pocket dosimeters, either of self-reading type or not, are available over wide ranges. They are now fairly rugged and reliable, but the general practice is to wear two of them to insure accuracy and to avoid gross error. They are not at all cheap and their universal use would be very expensive. It is also not considered advisable to provide self-reading dosimeters for distribution to all personnel.

Crystal dosimetry is now a possibility and will detect exposure upward from about 50 r. We would like it to start at a lower level, but this range should still be useful under certain conditions. A special phosphor glass is also under study and promises well.

#### THERAPY OF RADIATION ILLNESS

The difficult matter of therapy in radiation illness can be conveniently discussed under three main headings: Prophylaxis; Use of Specific Medication; General.

*Prophylactic Agents:* It would be very convenient if we were able to immunize

large numbers of people by a few simple injections, but unfortunately there is no real analogy to infectious diseases and no effective basis for immunological technic. It is a fact that experimental animals previously exposed may show increased resistance to single lethal-range doses but, except for this acute aspect, it is certain that the general harmful effects are always additive.

There is no simple remedy or injection that would be suitable for application to the general population as a prophylactic measure on the suspicion that an atom bomb might be used against us. Nevertheless, when calculated risks are involved, prophylaxis is well worth considering, both from the standpoint of general health and welfare and also of operational effectiveness. It has been noted that as little as 25 r in a single dose may be associated with some minor complaints, and exposures approximating 100 r may leave some individuals in a decidedly ineffective state for several days. The picture in regard to prophylaxis is about as follows:

Pyridoxine has been found beneficial in clinical radiation therapy for a number of years and could be given readily in tablet form.

Glutathione and cysteine have possibilities according to animal experiments but need to be evaluated clinically.

Flavonones have been reported to be helpful, but the work needs confirmation, and evaluation is still in a dubious state.

Folic acid and rutin have not stood the test of recent experimentation.

Antibiotics, as prophylactic agents, have produced good results in experimental animals but are scarcely advisable as prophylaxis for the ranges ordinarily envisioned in calculated risk exposures.

That about sums up this phase of the matter, except that we might remember that calculated risk exposure is likely to derive largely from fission products and that alpha, beta, and gamma rays of greatly varying intensity, and also K and L x-rays, will be involved. Thus, protective garments and partial shields may prove

quite helpful. It is obviously impossible to wear some 300 pounds of armor, but it may be possible to achieve limited or partial protection, e.g., over the upper abdomen, sternum and pelvic girdle, and also the hands.

*Specific Medication:* This phase of therapy is still in early stages of development, and the effectiveness of known agents leaves much to be desired. It is, however, well to bear the following in mind:

Vitamin B<sub>6</sub> (Pyridoxine), 25 to 50 mg. intravenously once or twice daily, may help relieve nausea and vomiting.

Vitamin C, 3,000 units daily, may hasten restoration of white cells.

Desoxycorticosterone acetate, 5 mg. intramuscularly or sublingually three or four times daily for not more than five consecutive days, may also help reduce nausea and vomiting. This is recommended by Dr. F. P. Ellinger.

Protamine sulfate and toluidine blue may have some possibilities in the hemorrhagic phases; dosages of 3 to 8 mg./kg. are mentioned by Lieut. Col. Albert J. Bauer in his concise résumé in Volume III of *Radiological Defense*.

Benadryl, in 50 to 100 mg. doses, may be helpful by virtue of its sedative effect and possible antihistaminic action.

Antibiotics become important as infection enters the picture. It is probable that a combination of penicillin and aureomycin or other types will be most helpful. The main difficulty relates to poor effects on pyocyanous organisms and some of the proteus groups.

*General measures*, although mentioned last, are among the most important. Patients with severe radiation illness have extremely urgent and varied problems:

(1) Water and electrolyte balance is disturbed, due both to direct effects of radiation and in still greater measure to nausea, vomiting, diarrhea, and hemorrhage. This may be further aggravated by shock and other trauma. Therefore, we come to the need for early intravenous injection of saline preparations, glucose, and plasma. Plasma, however, will have to be carefully

conserved. It is hoped that Dextran, Periston, and other substances will be found suitable as blood substitutes. These are at present the object of research.

(2) *Nutrition:* To maintain nutrition in the face of anorexia and other gastro-intestinal disturbances will be difficult. It is possible that recourse to our newer protein hydrolysates will be worth consideration, especially if they are improved and standardized, which appears likely to happen. Bland nutritive diets need to be provided up to the limit of the patient's ability to take food by mouth.

(3) *Anemia and Hemorrhage:* When anemia and hemorrhage are severe, it is natural to call for whole blood as well as blood substitutes, saline, and plasma, but there will be need for careful evaluation, as the supply will be greatly limited as compared to requirements. Moreover, the value of blood transfusions in early stages of radiation illness is still not demonstrated.

(4) *Infection:* Especial care and economy in parenteral technics are requisite; also avoidance of operations during the agranulocytic phase. Careful oral hygiene should be maintained. Antibiotics will, of course, be called for. Whole blood may be more important in combating this phase than for anemia and hemorrhage.

(5) *Morale:* Encouragement and reassurance are essential, more so than ever in view of great debilitation, nausea, anorexia, and possibly epilation.

(6) *Interval of Relative Well-Being:* The proper handling of this curious phase can contribute greatly to the number of recoveries and reduce medical burdens. In this stage there will be great susceptibility to fatigue, trauma, and exposure to unfavorable environmental conditions. To take care of the situation properly will not be easy and it involves identification (probably by location at time of blast), notification (radio-sound trucks), transportation, housing, and actual care.

The matter of operations and surgical procedures in general during this interval is worthy of special consideration. When they are essential to save life, then the



earlier they are instituted the better, since it would be well to anticipate the agranulocytic phase. However, the drawback is that people undergoing surgery even in this interval of relative well-being are apt to react poorly, show a greater mortality, and perhaps suffer from wound breakdown later. Operations, therefore, should be limited to cases of real necessity.

Thus, in general, personnel who have received a heavy dose of radiation are decidedly vulnerable to all adverse factors, so that the usual considerations of shelter and

protection from extremes of heat, cold, and damp become of paramount importance. Likewise, the greatest care and judgment in medical and nursing attention are essential.

This brings to a close a rather hurried and somewhat superficial survey. Time lacks for any detailed coverage, but it is hoped that these few remarks may furnish the basis for a better understanding and a stimulus to further study of these serious problems.

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#### SUMARIO

##### Justipreciación de los Riesgos Radiológicos y Terapéutica de la Enfermedad Irradiatoria

Toda valuación de los peligros acarreados por la radiación en condiciones de guerra entraña el problema de las grandes dosis orgánicas totales y del llamado "riesgo calculado."

En caso de necesidad aguda, el punto inmediato por considerar es la efectividad del personal. La aparición hasta de síntomas leves es susceptible de ocasionar alarma exagerada, lo cual indica la importancia de prestar atención profunda al estado de ánimo, a la indoctrinación con respecto a la importancia de los síntomas y a la dosimetría como medida de la exposición. A continuación de los efectos inmediatos de la radiación recibida en una sola exposición aguda, suele haber un período de bienestar relativo, seguido a su vez de efectos tardíos que pueden alcanzar proporciones graves si la exposición ha excedido de 200 r. Los efectos remotos son dignos de nota, no tan sólo en relación con exposiciones agudas aisladas sino con las exposiciones repetidas a pequeñas dosis. No obstante, la mayor parte de los sobrevivientes de la

enfermedad irradiatoria permanecen en buen estado.

En cuanto a riesgos calculados, puede considerarse que 25 r es el límite ordinario dentro del cual no hay para que esperar dificultades. Las exposiciones de 100 r dan motivo para graves preocupaciones; 200 r connotan grave enfermedad irradiatoria con alguna letalidad, en tanto que dosis mayores ocasionan rápida iniciación de incapacidad y mortalidad creciente.

Repásanse los problemas relativos a dosimetría, descubrimiento de irradiación y el tratamiento de la enfermedad irradiatoria. La terapéutica comprende profilaxis, farmacoterapia y providencias generales. Estas últimas comprenden medidas para combatir el desequilibrio hídrico y electrolítico, el mantenimiento de nutrición adecuada, el tratamiento de anemia y hemorragia, la atención al estado de ánimo y la evitación de infección, traumatismo, fatiga, esfuerzo y exposición a condiciones adversas en el ambiente, como son los extremos de calor, frío y humedad.

(For discussion of this and preceding papers, see following page.)



## DISCUSSION

(Papers by Bale; Cronkite; Schwob; Behrens)

**John D. Camp, M.D.:** The following question was sent in to the office of the College for an answer: "How would you decontaminate the bodies of patients brought to a hospital from a bombed area, and would you treat the broken limbs, knowing they were from a contaminated area? Dr. Schwob, would you like to answer that for us?"

**Dr. Schwob:** I believe the medical man's approach would be best in this instance. I would suggest decontamination with just soap and water; anything that can't be removed with that will not be of much consequence.

**Dr. Camp:** How should the soap and water be disposed of?

**Dr. Schwob:** Flush it down the drain. If it is from a bomb detonation, there will undoubtedly be very rapid decay. By the time it gets to its ultimate destination it will be fairly harmless, and if it is on the periphery of an area that is contaminated, it's not going to make much difference.

**Question:** What has been done from the point of view of getting the Federal Government to aid the states in purchasing monitoring equipment?

**Dr. Bale:** I thought Dr. Kiefer would be here and, since he was in charge of that problem, I didn't attempt to get information on the subject. I have seen an announcement that the Civil Defense Administration has agreed to pool orders for the so-called gamma ray monitoring instrument, and will try to get as good a price as possible for any defense groups that wish to buy these.

They have also sent out to manufacturers specifications for an ideal type of monitoring instrument, to see who can develop the best instrument, one that would be an improvement on the present "T-1" type. The Atomic Energy Commission also has developmental projects for instruments under way in two or three of its laboratories. These may prove useful for civil defense.

**Question:** There seems to be confusion in several of the defense organizations about two problems. One of these is: "Is prophylactic blood typing of any practical value?" Is local stockpiling of blood of any advantage for radiation injuries, and in which area would stockpiling be more sensible?

**Commander Cronkite:** It is with some hesitation that I answer that, because what would be the policy for civil defense might differ from my own personal views.

I can see no advantage in trying to do mass blood typing of the population. We tried to type

all personnel in the Navy in the last war, and there was a terrific error involved. Secondly, in metropolitan areas where you can type people with facility, you are going to type, as it were, "the cattle that are going to lose the blood." If you're going to do blood typing, it should be in the suburban areas, where the people are still going to be alive and can act as blood donors.

I think it is a fortuitous circumstance in respect to radiation energy that blood and antibiotics are probably of little value immediately, so that they can be used on the traumatic and thermal burns in the first week or so.

As to stockpiling blood, that is impossible. There is a three-week period in which it can be used, and that's about it. I think that stockpiling of antibiotics should be done on a large scale. Where such stockpiles should be located would be a matter for each state, each locality, or each region to decide. I think they should be segregated or disseminated widely, and integrated with the local civil defense set-up.

**Question:** General Cooney said to duck in case of an atomic explosion, to cover up your face, wait a minute and a half, and then it would be perfectly safe to go out and do rescue work. Dr. Schwob told us that in case the atomic explosion was under water or under ground, we ought to wait three or four hours. If you're in a ditch with your face covered up, how are you going to differentiate between these two explosions? I'd like to have a little further discussion on that.

**Captain Behrens:** That is a proposition that I think would be resolved by the nature of the explosion. It is probable that the open air burst sometimes would produce far more noise and far more flash. An underwater burst would give practically no flash. In an air burst, the first thing you get is a terrific flash of light, which is so intense that it pales the sunlight.

With the contaminating burst, of course, much of the reason for ducking is gone. I mean you can take a chance and duck, but if you're out in the open and get saturated with the radioactive rain, mist, water, or dust, it doesn't do much good to duck. That has reference to the type of explosion we call the air burst.

**Dr. Schwob:** I'd like to add one comment to what Captain Behrens has said. Speaking for myself, I would duck. I'd get down as fast as I could, remain for a very short time, and then immediately scour around to see if there were any shelter. You see, if it's a contaminating burst, if you have any chance of survival at all, it means that you are at least half a mile from the epicenter. It will take, roughly, twenty seconds or so for the

contamination to go half a mile. So I would first duck to protect myself from the thermal flash, and then I would look for shelter against any contamination.

**General DeCoursey:** I'd like to add one point. Dr. Schwob said "thermal flash." I would like to add "ionizing radiation." You can also duck some of that.

**Dr. T. E. Schmidt** (Jackson, Mich.): May I say a word in defense of mass blood typing? We don't spend a lot of money on blood typing. Commander Cronkite, it costs us approximately 56 cents to type a person. The population in our county is 110,000. We have blood typed for Rh and O factors in approximately 52,000 people. We do not yet have the "dog tags" and we don't guarantee that they will be worn, but at any rate we feel we have a start toward a walking blood bank. Whether or not it will be effective, I can't say. It was begun on a voluntary basis. The state then helped us out. We spent more money after the state got into it, but it can be done at rather nominal cost.

The inaccuracies of the blood typing method were less than 1 per cent. There were 46 errors out of 52,000, and they were stenographic errors, which subsequently will be corrected.

Before we decide against mass blood typing, I should like to make a plea that we do not throw it into the discard. It may be worth something, at any rate.

May I ask the decontamination specialists for some advice as to what to do about sewage and surface water disposal? If we are going to decontaminate our streets by detergents and water, our rooftops by the same method, and other materials by sandblasting, much of the waste is going into the sewage in many of our communities. Should anionic or cationic materials be put in there in order to make the effluent from those sewage disposal plants safe?

**Dr. Schwob:** I believe that is the \$64 question in any field of research nowadays in the atomic

field. Even for peace-time uses of radioactivity, large quantities of waste are created. I have heard such suggestions as putting the stuff in rockets and shooting it up high enough to follow a permanent orbit around the earth, or to shoot it up to the moon.

I do not quite understand your statement about adding anionic and cationic materials, surface-active agents, to sewage water, because that will do nothing except perhaps make the material a little bit more soluble. If the sewage results from a decontamination operation, it is probably in a form that would be very hard to change, as it would be in a fairly stable form by that time.

I would say that if you were going to wash your streets and the roofs and all that, let the waste into the sewer. You have an emergency, an immediate problem. The underground sewers will provide quite a bit of shielding; the activity coming off is not going to be very great—it would be less than if you had the stuff out in the street. It will decay very rapidly. While some day you'd like to go into the sewage system and decontaminate it, it's not an urgent problem.

I don't know what one would do with a city like Chicago, for example, where I understand a portion of the sewage eventually winds up in the lake, and not too far from the water intakes. That's another problem. I believe that cities should start evaluating such problems now, and find out whether it is safe to have a large amount of radioactive material in their sewers. If it isn't, then it's a definite engineering problem for them.

But without any further knowledge, I'd take a chance—at least for the first atomic bomb burst in my town—of letting the sewers get contaminated.

**Dr. Camp:** Somebody said this morning that there was nothing stimulating about an atomic bomb and the energy that comes from it, but I think what we have listened to today has certainly been most stimulating, and I hope it will arouse all of us to go home and better prepare ourselves for a job which I hope we never have to do. Thank you.



## Excretory Urography: A Clinical Trial of a New Contrast Medium (Sodium 3-acetylamino-2, 4, 6-triiodobenzoate)<sup>1</sup>

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A SAFE MEDIUM for excretory urography is the concern of all radiologists and urologists. Although this procedure has proved to be relatively safe, it has been attended by a few fatalities (1). For many years it has been known that reactions of varying degrees of severity may follow the intravenous injection of drugs. Most of these reactions are minor (a sense of warmth, flushing of the skin, nausea or vomiting, and arm pain), but at times they have been of such severity as to cause concern for the safety of the patient. While severe reactions are not common, the possibility of their occurrence must always be borne in mind in an active radiologic service. They represent a hazard which precludes the routine use of intravenous urography, and any precaution or any new preparation that further safeguards the patient during this examination deserves careful consideration.

### PRECAUTIONARY MEASURES

*Initial Precautions:* At the Massachusetts General Hospital, since 1948, certain precautions have been taken when intravenous administration of a contrast medium was to be done.

(1) Before ordering an intravenous urogram, the referring physician ascertains and notes in the patient's record (a) whether he is allergic or has a history of hay fever, asthma, eczema, or hives, and (b) whether Diodrast or a similar substance has been previously administered and

whether it or any other drug has caused a reaction. If affirmative answers are given to these questions, the possibility of substituting retrograde pyelography is considered. If, however, excretory urography is still considered necessary, the detailed information obtained is discussed with the radiologist and noted on the request for x-ray examination.

(2) An intravenous sensitivity test<sup>2</sup> is often done on the ward by the referring physician within twenty-four hours of the scheduled examination, and the result recorded on the x-ray requisition. The test consists of the intravenous injection of 1.0 c.c. Diodrast (35 per cent) diluted with 9.0 c.c. saline. The patient is observed carefully for one hour for signs of shock, flushing, urticaria, or other allergic manifestations. Should any be demonstrated, intravenous urography is not done.

(3) The blood non-protein nitrogen and the specific gravity of the urine are noted on the requisition. If the non-protein nitrogen is over 40 mg. per cent, or if the specific gravity is less than 1.015, intravenous urography is abandoned, unless the attending physician and the radiologist agree that information to be obtained from the examination warrants the risk.

*Other Precautions (for the Department of Radiology):* 1. It is imperative that there be on hand in the x-ray examining room, ready for immediate use, (a) ampules of epinephrine hydrochloride 1:1000, a sterile hypodermic syringe and needle;

<sup>1</sup> From the Department of Radiology and the Urological Service of the Massachusetts General Hospital, Boston. Accepted for publication in January 1951.

The contrast medium, "Urokon ®," has been supplied by its producers, the Mallinckrodt Chemical Works, St. Louis, who have met the expenses of this study.

<sup>2</sup> None of the so-called sensitivity tests have proved infallible or entirely reliable. Many allergists believe that the administration of even a very small amount of a substance to which a person is sensitive may be as serious as a large amount. Despite this possibility, and after considerable experience with the eye, tongue, intradermal, and intravenous tests, the policy of this hospital has been to employ the intravenous sensitivity test.

## CHART I

MASSACHUSETTS GENERAL HOSPITAL

RADIOLOGICAL DEPARTMENT

INTRAVENOUS PYELOGRAPHY

LAST NAME

UNIT #

DATE

TIME OF DAY

MEDIUM USED

DIODRAST

NEO-IOPAX

UROKON

HISTORY OF ALLERGY

REACTIONS OBSERVED IN RADIOLOGICAL  
DEPARTMENT:

1. Feeling of warmth
2. Arm pain
3. Nausea
4. Vomiting
5. Urticaria
6. Laryngeal edema (asthma, wheezing, etc.)
7. Unconsciousness

DELAYED REACTION:

NATURE

QUALITY OF EXAMINATION

EXCELLENT

FAIR

UNSATISFACTORY

A. Preparation

B. Density of Dye

C.

PREPARATION:

NONE FAIR GOOD

N. P. N.

SPECIFIC GRAVITY

SENSITIVITY TEST

PYRIBENZAMINE:

DOSE

(b) a flask of 5 per cent glucose in saline with appropriate apparatus for intravenous infusion.

2. Before injecting Diodrast or a similar substance, the technician's routine is as follows.

(a) The patient is asked the questions: (i) Have you ever had this type of examination before? (ii) If so, did you have a reaction? (iii) Have you ever had hay fever, asthma, hives, or eczema? (iv) Have you ever had a reaction to any injection? If the answer to any question is in the affirmative, the radiologist is consulted before the injection is given (2).

(b) A technician is never allowed to do intravenous urography alone.

(c) The orders for administration are: inject 1.0 c.c., stop, and watch the patient for two minutes (clocked) for signs of shock, flushing, urticaria, and other symptoms of allergy. If any are noted, consult the physician in charge; if not, continue the injection slowly over a period of five minutes.

(d) Any reaction following the intravenous injection is noted in the patient's record for future warning, and a special note is placed on the outer cover of the record.

While these precautions may not prevent a severe or fatal reaction, they are the most effective measures available, and their employment is evidence that the seriousness of the examination is recognized and that protective measures are being carried out.

Drug manufacturers have been working on new substances, attempting to find one which would produce fewer reactions. Recently a preparation of sodium 3-acetylamino-2,4,6-triodobenzoate has become available under the trade name "Urokon." Urokon contains 65.79 per cent iodine per molecule, compared with 49.8 per cent and 51.5 per cent in two other commonly used media. Animal experiments have shown the low toxicity of Urokon in rats, mice, dogs, and monkeys (3). In man, a 30 per cent solution for intravenous urography has been reported as causing fewer side reactions than other similar compounds (4, 5).

## PRESENT INVESTIGATION

In October 1949, an investigation into the comparative advantages and disadvantages of three intravenous contrast substances was undertaken as a joint project of the Department of Radiology and the Urologic Service of the Massachusetts

CHART II: REACTIONS FOLLOWING DIODRAST AND UROKON

Symptom	Diodrast					Urokon					Difference	
	A	B	C	D	E	A	B	C	D	E	F	G*
	No. Patients with Reactions	Per Cent of Total Cases	Additional Symptoms	Total Symptoms	Per Cent Incidence of Symptoms	No. Patients with Reactions	Per Cent of Total Cases	Additional Symptoms	Total Symptoms	Per Cent Incidence of Symptoms	Percentage Difference	Probability of Significance
Vomiting	64	4.5 ± 0.6	...	64	4.5 ± 0.6	74	4.8 ± 0.5	...	74	4.8 ± 0.5	-0.3 ± 0.8	...
Nausea	151	10.7 ± 0.8	64	215	15.2 ± 1.0	112	7.3 ± 0.7	74	186	12.1 ± 0.8	3.1 ± 1.3	9.1 1
Coryza	8	0.6 ± 0.2	7	15	1.1 ± 0.3	14	0.9 ± 0.2	5	19	1.2 ± 0.3	-0.1 ± 0.4	...
Urticaria	13	0.9 ± 0.2	2	15	1.1 ± 0.3	6	0.4 ± 0.2	3	9	0.6 ± 0.2	0.5 ± 0.3	2.1 1
Sub-total	236	16.7 ± 1.0	73	309	...	206	13.4 ± 0.9	82	288	...	3.3 ± 1.4	9.0 1
Vasomotor reactions	181	12.8 ± 0.9	101	282	19.9 ± 1.1	10	0.7 ± 0.2	10	20	1.3 ± 0.3	18.6 ± 1.1	10 <sup>45</sup> 1
Total reactions	417	29.5 ± 1.2	174	591	...	216	14.1 ± 0.9	92	308	...	15.4 ± 1.5	7 × 10 <sup>10</sup> 1
No reactions	998	70.5 ± 1.2	...	...	...	1,321	80.0 ± 0.9	...	...	...	...	...
Total cases	1,415	100.0	...	...	...	1,537	100.0	...	...	...	...	...

\*Probability of significance is expressed as odds against a similar or greater difference occurring by chance.  $\frac{7 \times 10^{10}}{1}$  is odds better than 70 billion to one. These calculations are interpolated from Pearl's tables (6).



General Hospital. The object of the study was twofold: (1) to compare the number and seriousness of the reactions, and (2) to determine the relative effectiveness of the media in delineating the urinary tract. After a few weeks trial, one of the substances was discontinued because of the universal complaint of severe pain in the arm from the group of patients on whom it was employed. The following report is based on the results of 2,952 examinations with the remaining two substances; 1,537 with Urokon and 1,415 with Diodrast. The selection of patient and medium was random. In both groups the routine precautionary measures outlined above were carried out.

Standard dosages of 25 c.c. of 30 per cent Urokon and 20 c.c. of 35 per cent Diodrast were used, with appropriate reductions of dose for the comparatively small number of children included in the series. In the Diodrast group a few patients with a history of allergy were given pyribenzamine prophylactically; none of the Urokon group received this drug. Nine patients were included in the study who had had a previous reaction to Diodrast: 2 of these received Diodrast again and both had reactions, while of the 7 who received Urokon only one had another reaction.

Symptoms and signs of reactions to the injections were carefully observed and recorded on a standard chart (Chart I); the minimum observation period was thirty minutes. All untoward signs and symptoms were recorded, thus reducing error due to individual interpretation.

Chart II records the reactions that occurred in the 2,952 examinations. In Column A each patient is counted once; if he experienced more than one symptom he was listed under the symptom standing highest on the list. (These have been arbitrarily arranged in decreasing order of subjective seriousness.) Column A, therefore, records the total number of examinations performed in which one or more reaction occurred. Column D, on the other hand, shows the totals for each symptom.

The study indicates that vasomotor

reactions are fifteen times as frequent when Diodrast is used. One or more of the following signs—vomiting, nausea, coryza, urticaria—was noted in 13.4 per cent of the patients receiving Urokon as contrasted to 16.7 per cent of those receiving Diodrast.

The vasomotor reactions have been considered separately because it became evident early in the course of the investigation that they occurred almost exclusively with Diodrast. Included in this category are signs and symptoms ranging from the very frequent flushing of the face and feeling of warmth to chills, weakness, and *unconsciousness*, this last occurring in only one patient, who was in the Diodrast group. The high incidence of minor vasomotor reactions is not a deterrent to the use of Diodrast as compared with Urokon, since they seldom caused significant inconvenience to the patient or to the conduct of the examination. *If, however, the few cases that proceeded toward serious vasomotor collapse are an indication of the approach to fatal reaction*, the very low incidence of vasomotor response to Urokon is a strong recommendation of its comparative safety to the patient.

In the Diodrast group,  $9.8 \pm 1.6$  per cent of the patients having reactions had a positive allergic history, as compared with  $10.2 \pm 2.1$  per cent in the Urokon group; not a significant difference. Of the entire series, 170 had a history of allergy; 63 ( $35.6 \pm 3.6$  per cent) had a reaction to one of the two drugs. Of the 2,775 patients with a negative allergic history, 570 ( $20.5 \pm 0.8$  per cent) had a reaction. There was thus a  $15.1 \pm 3.7$  per cent greater incidence in the allergic group.

Comparison of the diagnostic quality of the films obtained with the two contrast media by accurate statistical evaluation was impossible. The difficulty of balancing the many variables—presence or absence and severity of renal disease, the preparation of the patient, and technic—was insurmountable. In general, the density of the media was equal in the two groups; apparently good concentration is obtained in the kidney pelvis more rapidly with

Urokon. In view of the rapidity of excretion of this newer medium, it was found that the usual technic for urography could be modified so that films were taken at four and eight minutes instead of five and ten. After the eight-minute film, the technician shows the films to the radiologist, who directs the taking of further films if they are necessary. In a busy radiologic department, this saving of a few minutes time on many patients is of significance. The same factors in technic are of importance when Urokon is used as when other agents are chosen. Selection of proper kilovoltage, short exposure time, and adequate compression are essential.

#### SUMMARY

1. An investigation into the comparative advantages and disadvantages of two intravenous contrast substances, sodium 3-acetylamino-2,4,6-triiodobenzoate (Urokon) and iodopyracet (Diodrast), has been carried on for the past year. The results of 2,952 examinations have been analyzed. In 1,537 of these Urokon was the contrast substance and in 1,415 Diodrast was used.
2. Many more vasomotor reactions oc-

curred with Diodrast than with Urokon, but approximately the same number of other minimal reactions were experienced by the patients in each group. No serious reactions, such as loss of consciousness, were noted in the Urokon group; one occurred in the Diodrast group.

3. The diagnostic quality of the x-ray films was not appreciably different with the two media. Urokon appeared to be more rapidly excreted than Diodrast.

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#### SUMARIO

##### Urografía Excretoria. Prueba Clínica de un Nuevo Medio de Contraste (3-Acetilamino-2,4,6-triiodobenzoato Sódico)

Durante el año pasado, se ha llevado a cabo una investigación de las comparativas ventajas y desventajas de dos sustancias de contraste para uso intravenoso: 3-Acetilamino-2,4,6-triiodobenzoato Sódico (urokón) y yodopiracet (diodrasto). Los resultados de 2,952 exámenes fueron analizados, empleándose en 1,537 de ellos urokón como sustancia de contraste y en 1,415 diodrasto.

Los resultados del estudio indican que hubo muchas más reacciones vasomotoras

con diodrasto que con urokón, pero que experimentaron aproximadamente el mismo número de reacciones los enfermos de ambos grupos. No se notaron reacciones graves, tales como pérdida del conocimiento, en el grupo del urokón, pero hubo una en el del diodrasto.

La calidad diagnóstica de las radiografías no discrepó apreciablemente con los dos medios. El urokón pareció ser excretado algo más rápidamente que el diodrasto.

## Pulmonary Artery Thrombosis: Roentgen Manifestations<sup>1</sup>

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THROMBOSIS OF the pulmonary arterial tree may result in the production of a pulmonary infarct, which customarily involves only a portion of the area supplied by the thrombosed vessel, or extensive thrombosis may be present without causing pulmonary infarction. The roentgenographic detection of pulmonary infarct is a frequent problem for the roentgenologist. In the absence of infarction, the detection of vascular changes in the lung resulting from embolism or thrombosis may sometimes be possible. When infarction is present, there is additional cause to suspect and search for evidence of thrombosis in the pulmonary arteries. Although an extensive literature exists on the pathologic and clinical aspects of pulmonary thrombosis, only a few authors have concerned themselves with its roentgen manifestations.

Thrombosis in the pulmonary arterial tree, especially in the smaller vessels, is relatively frequent; as a rule it does not result in infarction (16, 24, 35, 36). Extensive studies have been made by Møller (24), who found arterial thrombosis in 29 per cent of 176 postmortem examinations, and by Brenner (6), who reported an incidence of 28 per cent in 100 consecutive routine autopsies.

The most common etiologic factor in pulmonary arterial thrombosis is embolism from the systemic veins or from the right heart. Infection (10, 15, 28, 31), phlebotrombosis and thrombophlebitis (1, 6, 8, 10, 20), cardiac disease (28), age, and surgery (1, 8), all contribute to the formation of pulmonary thrombi.

Thrombosis may occur *in situ* in the pulmonary arterial tree in (a) cases of parenchymal disease of the lung such as tuberculosis (21, 26, 28), silicosis (28), sar-

coidosis (32), chronic (28) or acute (11) infection, and carcinoma (3), and (b) in cases of altered circulation of the pulmonary tree. The latter include rheumatic heart disease (8, 28), tetralogy of Fallot (27), interauricular septal defect (34), patent ductus (14, 29), Eisenmenger's complex (30), interventricular septal defect (7), and congenital dilatation of the pulmonary artery (13). When congenital or rheumatic heart disease is present, superimposed subacute bacterial endocarditis may be the immediate cause of the thrombus formation (14, 29). Some of the less common causes of pulmonary thrombosis *in situ* are sickle-cell anemia (37), trauma to the chest (17), thrombo-angiitis obliterans of the pulmonary artery (18), measles complicated by pneumonia (11), and polycythemia (19, 25, 38).

The sex incidence of pulmonary thrombosis appears to be about equal, as was found by Savacool and Charr (28) in a series of 100 cases. Although persons in the older age groups are more apt to be afflicted, a number of cases in infants and children have been reported (11, 15, 17, 31).

Clinically the initial signs and symptoms of the disease may be either insidious or of dramatic onset (22, 23, 28). They may be primarily those of the thrombosis itself, that is, the result of the initial embolism, of infarction when it occurs, or, in cases of long standing, embarrassment of the right heart with chronic cor pulmonale. They may, on the other hand, be masked by manifestations of some other more apparent disease. There is experimental evidence to support the clinical and pathologic findings of large thrombi in the pulmonary vascular tree which have exhibited minimal signs and symptoms. The short-term ex-

<sup>1</sup> From the Department of Radiology, Massachusetts General Hospital, Boston 14, Mass. Presented at the Thirty-sixth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 10-15, 1950.

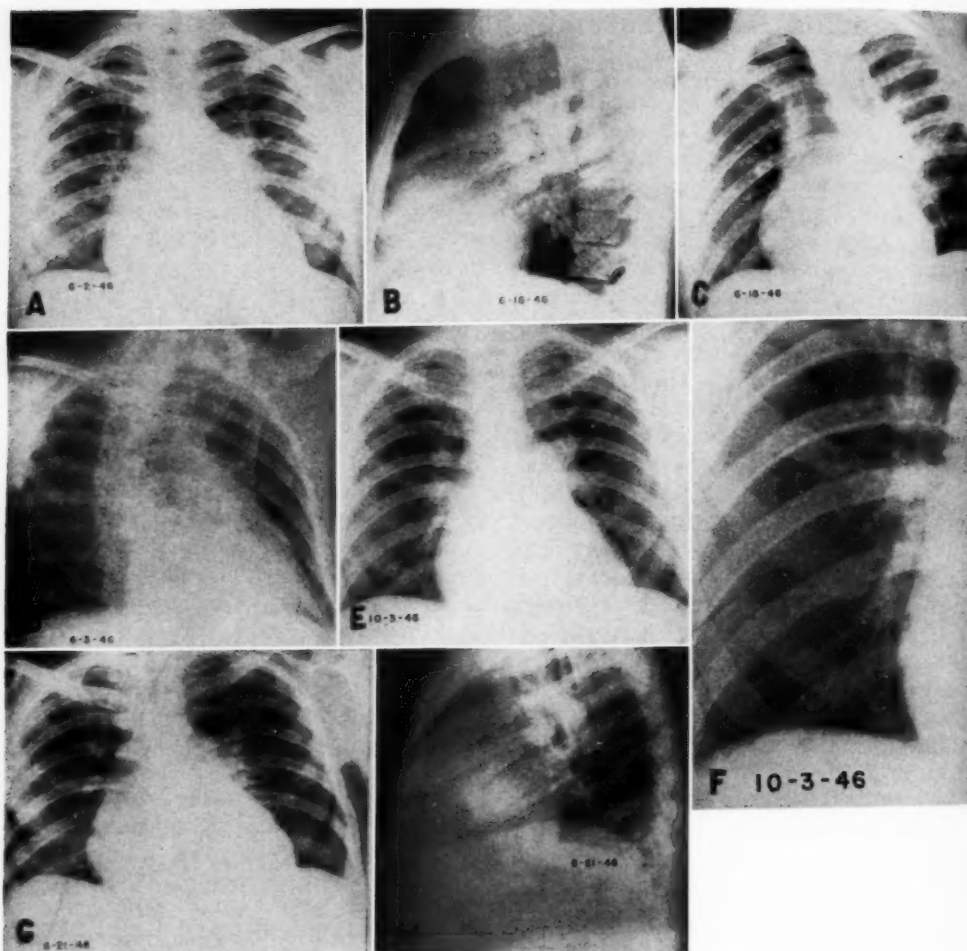


Fig. 1. Case 1: Chronic cor pulmonale due to thrombosis of main, right and left pulmonary arteries. A-F. Roentgenograms of chest, 1946. The right ventricle and undivided portion of the pulmonary artery are prominent, and the left main bronchus is somewhat narrowed due to pressure from the enlarged left pulmonary artery. At the left hilus, the visualized proximal portions of the branches of the left upper lobe are large. Particularly well shown in the left anterior oblique film (C) is the enlarged angular contour of the left pulmonary artery to the lower lobe and the relatively small size of the vessels that proceed from it. In contrast to the left side, the right hilar shadow is small. Shown best in E and F is the diminished caliber of the right interlobar artery. Instead of the usual slight lateral convexity, it shows a slightly concave lateral border, and the distal branches are reduced in size. There is increased radiolucency of the lower half of the right lung field. A, B, and E show the left lower lung field also to contain few vascular shadows.

G and H. Roentgenograms made two years later, six months before death. These films are not strictly comparable, as the diaphragm is higher in position; they reveal no changes which cannot be attributed to this difference.

See also Fig. 1, I.

periments of Gibbon, Hopkinson, and Churchill (12) on dogs demonstrated that the cross-section of the pulmonary artery could be greatly reduced before the systemic pressure fell and that a reduction of 84 to 96 per cent might occur before death

ensued. At autopsy the pathologist may describe thrombi as "occluding" the main pulmonary artery or both right and left branches, yet *in the absence of an interauricular or interventricular septal defect, it is apparent that the patient's entire cardiac*



output passes through the channels which are described as occluded.

The first report on roentgen findings in pulmonary thrombosis was that of von Dehn (33) in 1910; he noted large hilar shadows on a chest film. In 1931, Boswell and Palmer (4) described the changes in a 39-year-old male and reproduced the chest roentgenogram illustrating the manner in which the thrombus lay in the artery. The unusual size of the right interlobar artery<sup>2</sup> was mentioned. In the same year, Wahl and Gard (34) reported a case of thrombosed aneurysmal pulmonary arteries in a patient who had an interauricular septal defect; chest roentgenograms were shown. Westermarck (35) in 1938 and again ten years later (36) described the changes in the lung periphery, consisting of decrease in the apparent number of vessels and increase in radiolucency in the area supplied by the thrombosed vessels. He also mentioned the changes visible in the major vessels—increase in size and apparent abrupt termination of the vascular shadows. Hampton and Castleman (16), in their study of embolism and infarction (1940), reproduced a chest roentgenogram, as well as a photograph of the pathologic specimen, demonstrating extensive thrombosis of the pulmonary arteries. They commented on the enlargement of the right heart and the dilatation of the hilar vessels. More recently (1948) Shapiro and Rigler (30) confirmed previous findings and showed roentgenograms of two cases proved by autopsy.

Five cases of thrombosis involving the main pulmonary artery or its major branches, encountered at the Massachusetts General Hospital, are presented in detail. In these five cases the roentgen changes have consisted of alteration in hilar contours, changes in the vascular pattern in the lung fields, and right heart enlargement in long-standing cases. All these changes have been previously recorded

<sup>2</sup>The interlobar artery (5) is the portion of the pulmonary artery distal to the origin of the upper lobe branches; it gives rise to the middle and lower lobe branches and forms the major portion of the hilar shadow.



Fig. 1, I. Case 1: Diagram showing position of thrombi.

in the literature, but the right heart enlargement which occurs in chronic cases has not been stressed and further emphasis on it and on the correlation of the altered contour and the shape of the contained thrombus seems justifiable.

A single case of multiple thrombosis of the tertiary vessels, which demonstrates the difficulty of the differential diagnosis (2, 9) is also described.

#### CASE HISTORIES

CASE 1<sup>2</sup>: C. S., a 22-year-old white male, was first seen in 1938 because of swelling and pain in the lower legs following exertion or exposure to cold. Ulcerations developed over the malleoli. In 1944 the patient first experienced shortness of breath on exercise previously well tolerated. In 1946 he entered the hospital because of hemoptysis. A cupful of bright red blood was raised, without associated pain.

Examination disclosed slight cyanosis, massive anasarca, distention of the neck veins, and a large heart with an apical systolic murmur.

Laboratory studies showed a total protein of 5.6 gm. per cent and hemoglobin of 10.5 gm. The electrocardiogram showed right axis deviation. Vital capacity was 3.6 liters.

The edema proved somewhat refractory. During the years 1946 to 1948 there were repeated admissions for congestive failure with massive edema and hemoptysis. The twelfth and final admission was for gangrene of the third and fourth toes of the right foot. The patient became frankly psychotic and was

<sup>2</sup>Case 35,081, New England J. Med. 240: 303-308, Feb. 24, 1949.



discharged to a psychiatric institution, where he shortly expired.

*Roentgen examination* demonstrated enlargement of the right heart, decrease in vascularity of portions of the lungs, large ragged contour of the left hilus, and a decrease in size of the right hilus (Fig. 1).

*Postmortem Protocol* (pertinent findings): The pulmonary artery contains many 0.5 cm. atheromata on the intima and the artery appears moderately dilated. Starting about 6 cm. above the pulmonary valve and approximately 3 cm. below the bifurcation of the pulmonary artery is a laminated, well organized thrombus densely adherent to the intima of the pulmonary artery and containing some calcification in its deeper portions. The thrombus appears to occlude completely the pulmonary artery to the left lung and to occlude at least 50 per cent of the lumen of the artery to the right. Some of the smaller radicles of the pulmonary artery appear to be occluded by small web-like structures which microscopically are shown to be recanalized thrombi. Microscopic study of the thrombus reveals a considerable degree of organization in the older portions and the deposition of fresh layers on top of them.

The heart weighs 610 gm. The myocardium of the right ventricle measures 10 mm. in thickness; that of the left 24 mm.

*Comment:* Right heart failure resulted from long-standing pulmonary arterial thrombosis of both large and small arteries. The pulmonary emboli originated in thrombosed vessels of the lower legs. The roentgen changes consisted of right heart enlargement, enlargement of the pulmonary artery and the left main artery, decrease in size of the right interlobar artery, and decrease in vascularity of portions of the lung fields. Despite the extensive thrombosis, there was complete absence of gross pulmonary infarction. The small size of the right interlobar artery and its branches was due to a thrombus proximal to the hilus in the right pulmonary artery. The thrombus apparently extended far enough to the left to cause enlargement of the left hilar contour but stopped more medially on the right side. It was of considerable duration, as evidenced by the extent of the organization and the calcification within it, as well as by the hypertrophy of the right heart and the absence of change in the appearance of the chest during the last two years of the patient's life.

CASE 24: J. G. S., a 73-year-old white female physician, entered the hospital because of swelling of the right leg of two days duration. Five weeks before entry, she had a chill and probably fever; a similar episode had occurred three weeks prior to admission. She grew steadily weaker, and two days before admission swelling of the right leg was noted by the district nurse. Thirty years previously the patient had had influenza and during the same year phlebitis of the right leg.

The patient weighed approximately 260 pounds and her blood pressure was 130/70, with irregular cardiac rhythm, faint heart sounds, pitting edema of both feet, and brawny swelling of the entire right leg to the hip. No pulse could be felt in this leg below the femoral artery.

The hemoglobin was 12.2 gm. per cent. An electrocardiogram showed auricular fibrillation with ventricular rate averaging 70; axis and voltage normal.

Because of the patient's age and condition, ligation of the veins was thought to be contraindicated. Her right leg enlarged progressively; on the twelfth day she was found cyanotic and gasping, and she died within ten minutes.

*Roentgen examination* showed a ragged, enlarged contour of the left hilus and avascularity of the lung fields (Fig. 2).

*Postmortem Protocol* (pertinent findings): The examination is restricted to a chest incision. Two infarcts are found in the right lower lobe.

An organized thrombus straddles the bifurcation of the pulmonary artery and extends to the right and left and into all the major branches of each pulmonary artery. The thrombus is pale yellow and firmly attached posteriorly to the walls of the arteries. A coil of dark red blood clot varying in diameter from 4 to 10 mm. lies beside the pale yellow thrombus in the right and left main pulmonary arteries.

The heart weighs 460 gm. The right ventricle measures 4 mm. in thickness, the left 11 mm. The myocardium shows no evidence of infarction.

*Comment:* The gross and microscopic appearance of the pulmonary thrombus indicates that it was already well organized at the time of hospital admission, when the chest roentgenogram was made. Its possible duration is suggested by the chills and fever which the patient experienced before entry. This episode may have been a manifestation of the development of thrombosis in the veins of the right leg or of pulmonary embolism. The ragged contour of the enlarged left hilus corresponds closely in size and shape to the thrombus which was found within the interlobar artery and

\* Case 33,301. New England J. Med. 237: 132-135, July 24, 1947.

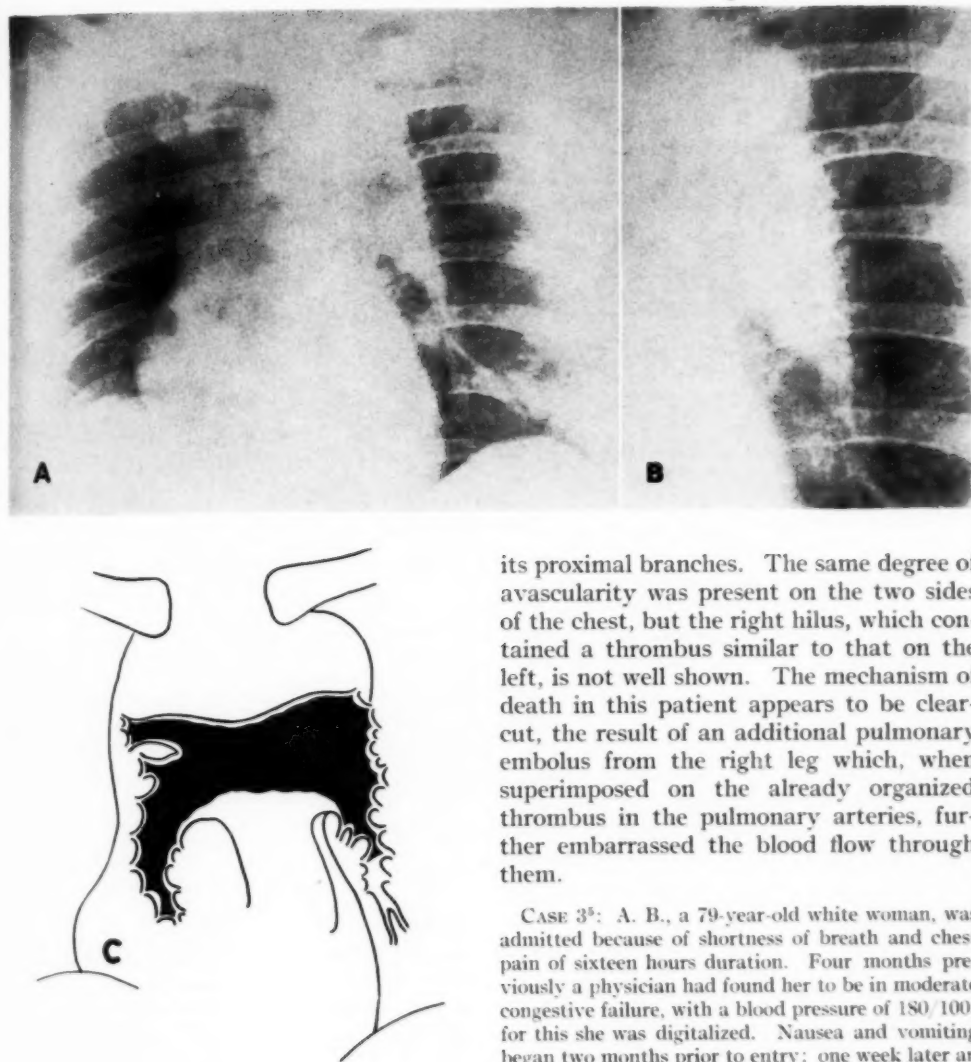


Fig. 2. Case 2: Thrombosis of right and left pulmonary arteries with extension into proximal branches.

A. A somewhat rotated anteroposterior projection made with the patient in bed shows marked enlargement of the left pulmonary artery at the hilus. Below the maximal hilar density are seen only a few rather small vessels proceeding to the lower lobe. At a point where other vessels to the lower lobe would ordinarily be expected to emerge, two rounded projections are seen. The right hilus is obscured by the heart. The vascular shadows in the peripheral portions of each lung field are reduced in number and size; this results in the appearance of increased radiolucency.

B. Detail view of left hilus showing enlargement and altered contour of the interlobar artery resulting from the thrombus within it.

C. Diagram showing position of thrombi.

its proximal branches. The same degree of avascularity was present on the two sides of the chest, but the right hilus, which contained a thrombus similar to that on the left, is not well shown. The mechanism of death in this patient appears to be clear-cut, the result of an additional pulmonary embolus from the right leg which, when superimposed on the already organized thrombus in the pulmonary arteries, further embarrassed the blood flow through them.

CASE 3<sup>5</sup>: A. B., a 79-year-old white woman, was admitted because of shortness of breath and chest pain of sixteen hours duration. Four months previously a physician had found her to be in moderate congestive failure, with a blood pressure of 180/100; for this she was digitalized. Nausea and vomiting began two months prior to entry; one week later an appendectomy was performed at another hospital. Vomiting persisted, and one week before admission there was sudden onset of chest pain which radiated down the left arm. This was relieved by bed rest. Thirty-six hours before entry the patient again complained of pain in the chest, this time more severe, accompanied by difficulty in breathing and the raising of dark material.

The patient was well developed, obese, and disoriented, with a slight degree of cyanosis, distention of the neck veins, enlarged heart, and blood pressure of 135/55.

The hemoglobin was 13 gm.; prothrombin time

<sup>5</sup> Case 34,242. *New England J. Med.* 238: 847-850, June 10, 1948.

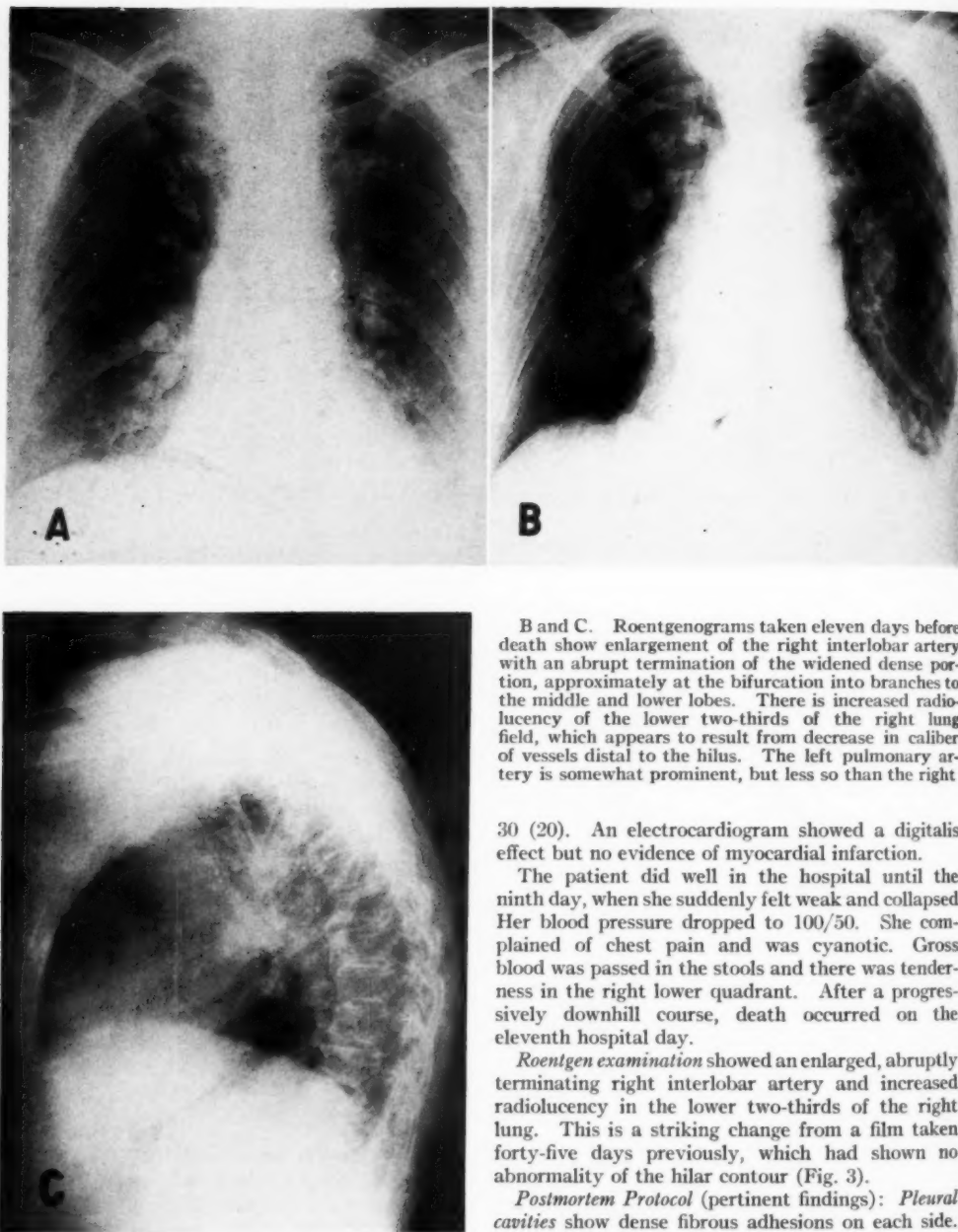


Fig. 3. Case 3: Thrombosis of right pulmonary artery and segmental branches to left upper and lower lobes.

A. A chest roentgenogram taken fifty-six days prior to death (reproduced by courtesy of Dr. Felix G. Fleischer) shows no significant abnormality of the pulmonary vessels; in particular, the lung roots are not unduly prominent.

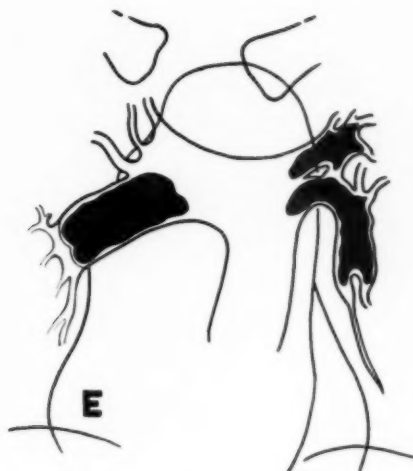
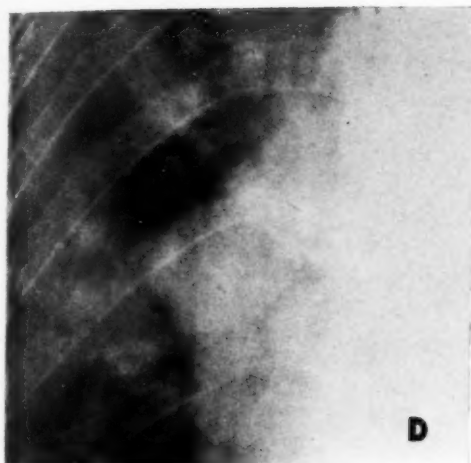
B and C. Roentgenograms taken eleven days before death show enlargement of the right interlobar artery with an abrupt termination of the widened dense portion, approximately at the bifurcation into branches to the middle and lower lobes. There is increased radiolucency of the lower two-thirds of the right lung field, which appears to result from decrease in caliber of vessels distal to the hilus. The left pulmonary artery is somewhat prominent, but less so than the right

30 (20). An electrocardiogram showed a digitalis effect but no evidence of myocardial infarction.

The patient did well in the hospital until the ninth day, when she suddenly felt weak and collapsed. Her blood pressure dropped to 100/50. She complained of chest pain and was cyanotic. Gross blood was passed in the stools and there was tenderness in the right lower quadrant. After a progressively downhill course, death occurred on the eleventh hospital day.

*Roentgen examination* showed an enlarged, abruptly terminating right interlobar artery and increased radiolucency in the lower two-thirds of the right lung. This is a striking change from a film taken forty-five days previously, which had shown no abnormality of the hilar contour (Fig. 3).

*Postmortem Protocol* (pertinent findings): *Pleural cavities* show dense fibrous adhesions on each side. Practically the entire *right lower lobe* is infarcted. There are areas of atelectasis in the left lower lobe and left upper lobe. The *right pulmonary artery* at the hilus is completely occluded by a reddish-gray, firm, friable thrombus which has extended into the main branches to the lower and middle lobes. There is slight reaction about the thrombi in the smaller branches so that they are adherent to the



D. Detail view of the right hilus (from B), showing striking change in contour of the interlobar artery resulting from contained thrombus.

E. Diagram showing position of thrombi.

lining of the vessels, and the thrombi are found to be organizing. The vessels to the left lower lobe and left upper lobe contain similar thrombi, and there are a similar reaction and organization about the extension into the smaller branches.

The heart weighs 360 gm. The thickness of the right ventricle is 4 mm., that of the left 16 mm. An organizing mural thrombus is found on the posterior wall of the right ventricle between the trabeculae carneae. There is infarction of a portion of the lower ileum and areas of congestion are present in the jejunum and the colon. A thrombus is present in the left popliteal vein, which is laminated, friable, and adherent to the wall of the vessel.

**Comment:** In this 79-year-old woman emboli were apparently showered to the lungs from a popliteal vein or the right ventricle. Her long-standing congestive failure may have contributed to the formation of the peripheral thrombi. In this case there is excellent demonstration of the distal end of the bulky extremity of the thrombus in the right interlobar artery. This portion of the thrombus must have formed in the forty-five-day interval between the roentgen examinations. The paucity of vascular shadows in each lower lung field and the moderate enlargement of the left hilus indicate bilateral thrombosis.

**CASE 4:** M. D., a 76-year-old white female clerk, entered the hospital because of constipation, abdominal pain, and bloody stools. For about one year

prior to entry she had noticed some dyspnea on climbing a flight of stairs.

Examination disclosed a carcinoma of the rectum. The heart was enlarged, the blood pressure 180/100, and the electrocardiogram showed left axis deviation. The carcinoma was resected in two stages. Postoperatively abdominal abscesses developed. On the thirty-eighth postoperative day some cough was noted, and on the following day the left calf was found to be tender and slightly bluish. A chest film made at that time was interpreted as showing an infarct, and bilateral common femoral vein interruptions and a left common femoral thrombectomy were performed. Following the development of a small bowel fistula, the patient's course was progressively downhill, and she died fifty-eight days after the second stage of the resection.

**Roentgen examination** made two weeks prior to death showed a definite change in the appearance of the chest from that which had been noted two months earlier. The later films showed infarcts in the right lower lobe, decrease in the number of vessels apparent in the right lower lung field, and enlargement of the right interlobar artery, which terminated in two conical projections (Fig. 4).

**Postmortem Protocol** (pertinent findings): The bronchial lymph nodes are moderately congested; the largest measures approximately 2 cm. in diameter. There is an infarct of several weeks duration, as well as a healing infarct in the right lower lobe. Several recanalized vessels are present. The right pulmonary artery is partially occluded by a branching, pinkish-red, well formed, moderately firm thrombus extending from a point slightly distal to the bifurcation of the pulmonary artery into the major branches, with slender extensions into these branches and into the segmental branches. At

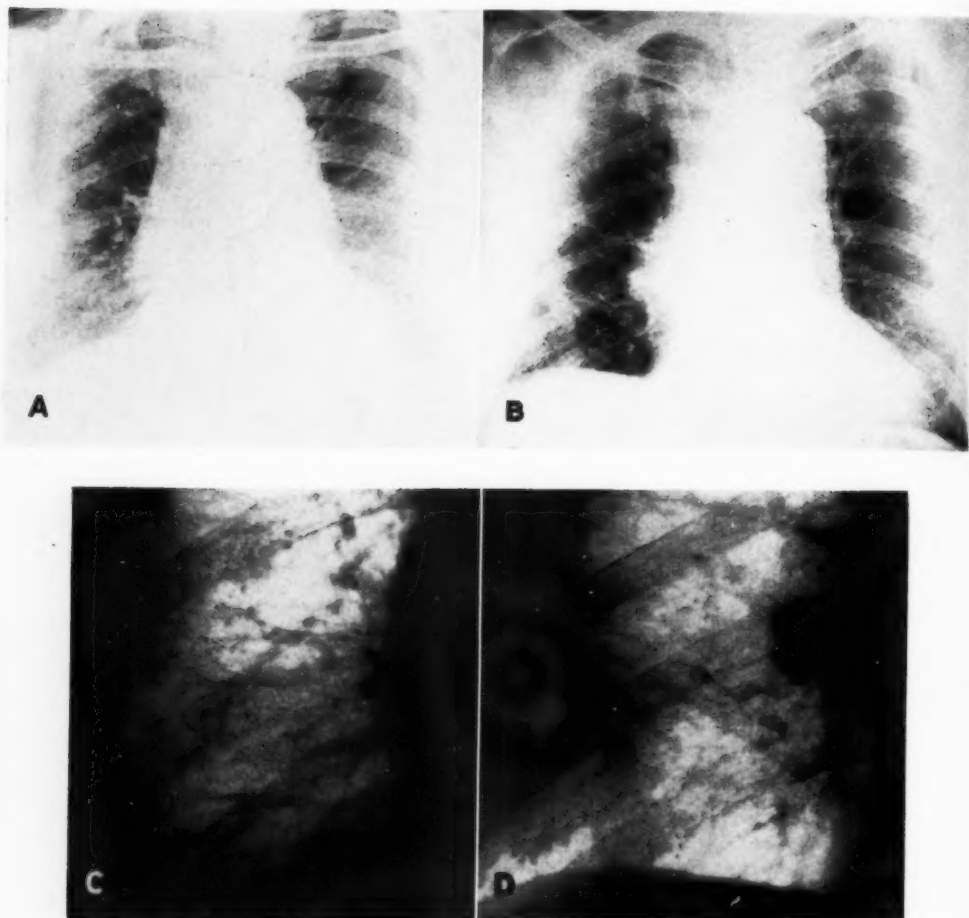


Fig. 4. Case 4: Thrombosis of right pulmonary artery.

A. Postero-anterior view two and a half months before death and prior to onset of thrombosis. Symmetrical vascularity of both lungs.

B. Twelve days before death. The right lower lung field has changed, now showing longitudinal and transverse densities, resulting from infarction, and decreased vascularity. The enlarged right interlobar artery terminates in two conical projections with few vessels proceeding from it.

C and D. Contact prints of lower portions of right lung made from A and B, respectively, showing change in vascular pattern and altered hilar contour.

E. Diagram showing position of thrombi.

some points the thrombus is softly adherent; at others it hangs free, suggesting that blood was able to pass around it. Its greatest diameter is 2.6 cm.

The heart weighs 250 gm. The thickness of the right ventricle is 4 mm., that of the left 12 mm. The cavities are of normal caliber.

The left iliac vein is completely occluded by reddish, adherent, formed thrombus. Examination of the sites of the previous vein interruptions shows the common femoral veins to have been sectioned and ligated bilaterally. There is relatively old thrombosis, similar to that in the pulmonary artery, both



proximal and distal to the ligatures on the left. The right side is clear.

**Comment:** Postoperative venous thrombosis led to pulmonary embolization and thrombosis of the right pulmonary artery. A large pulmonary embolus probably was dislodged at the time of the femoral vein ligation twenty-eight days before death, but the possibility that the thrombus was of shorter duration and had origin in the iliac vein thrombosis cannot be excluded. The shape of the right interlobar artery had been altered by the thrombus within it and its abrupt termination corresponds closely to the tapering of the bulky portion of the thrombus. The apparent decrease in the number of vascular shadows in the right lower lung field between the two examinations is largely the result of the pulmonary thrombosis.

CASE 5\*: A. C., a 69-year-old white male with a history of rheumatic valvular disease dating back to an attack of polyarticular rheumatism and chorea at the age of thirteen, entered the hospital because of shortness of breath on exertion. He had done heavy work as a blacksmith and farmer for most of his adult life. Fifteen years before admission a cardiac arrhythmia had developed, since which time he had taken digitalis. Following an episode of polyarticular pain and swelling two years prior to entry, he began to be aware of exertional dyspnea accompanied by substernal distress. Intermittent paroxysmal nocturnal dyspnea associated with interscapular pain had persisted. In the three months preceding hospitalization, dyspnea and orthopnea had become pronounced, and for one week there had been a persistent productive cough.

The patient was asthenic and somewhat cyanotic, with a grossly irregular pulse of 92 and blood pressure of 130/80. The neck veins were flat, and there was no peripheral edema. The heart was enlarged. There was a grade III systolic murmur at the apex, transmitted to the base and audible over the entire precordium, as well as a suggestion of a low-pitched apical diastolic murmur.

Hemoglobin was 14.4 gm. per cent. The electrocardiogram showed flutter fibrillation with an average rate of 80 and suggested left ventricular enlargement.

On the fourth hospital day there was a sudden deepening of the patient's cyanosis and increase in dyspnea, unaccompanied by pain. His temperature rose to 103°. He was given oxygen, penicillin, and morphine without clinical improvement. On

the seventh day a small hemoptysis occurred, and the blood pressure fell to 90/60. The following day the chest was filled with râles and the blood pressure dropped to 70/40. The patient failed rapidly and died that evening.

**Röntgen examination** on admission showed a normal vascular pattern in the lungs, with moderate prominence of each lung root. A bedside film obtained on the day of death revealed a large infarct in the right upper lobe and relative avascularity of the rest of the right lung (Fig. 5).

**Postmortem Protocol** (pertinent findings): Dense fibrous adhesions are present over the right lung, confining it to the pleural surfaces and superior surface of the diaphragm. The right upper lobe contains an extremely firm, roughly triangular consolidated area 8 cm. in greatest diameter, which occupies principally the apex of the lobe. Both grossly and histologically it has the appearance of a relatively recent infarct. Edema is present in the lower lobes. No gross atelectasis is apparent.

In all its main branches the pulmonary artery contains abundant firm, yellow atheromatous plaques measuring up to 4 mm. in diameter. In the right main pulmonary artery there is a firmly adherent reddish thrombus which extends into the artery to the right upper lobe and occludes it completely. Distal to the adherent thrombus a recent dark red, jelly-like thrombus extends into the smaller arteries to the right upper lobe.

The heart weighs 570 gm. The myocardium of the right ventricle measures 5 mm., and that of the left 15 mm., in thickness. The muscle of the right ventricle is more firm than that of the left, and the greater part of the septum is softened. Histologically there is extensive infarction of the left ventricle and septum. The columnae carneae of the right ventricle are greatly hypertrophied; those of the left are of normal size. Both right and left auricles are grossly dilated, as is the cavity of the right ventricle. The cusps of the mitral valves are fused and show atheromatous degeneration and calcification. The valve orifice is C-shaped and rigid. The aortic valve shows fusion of cusps for a distance of 5 to 7 mm. from their origin, and the valve appears to be physiologically incompetent.

The main branches of the coronary arteries contain soft, irregular atheromatous plaques, and there is evidence of old and recent occlusion of the left anterior descending and right circumflex vessels. No thrombi are found in the veins of the extremities.

**Comment:** In the absence of a demonstrable thrombus of the peripheral veins and in the presence of rheumatic heart disease, it is possible that thrombosis occurred *in situ* in the pulmonary arterial tree. The thrombus resulted in the development of a large infarct in the apex of the right upper lobe. No gross atelectasis

\* Case 36,232. New England J. Med. 242: 912-915, June 8, 1950.

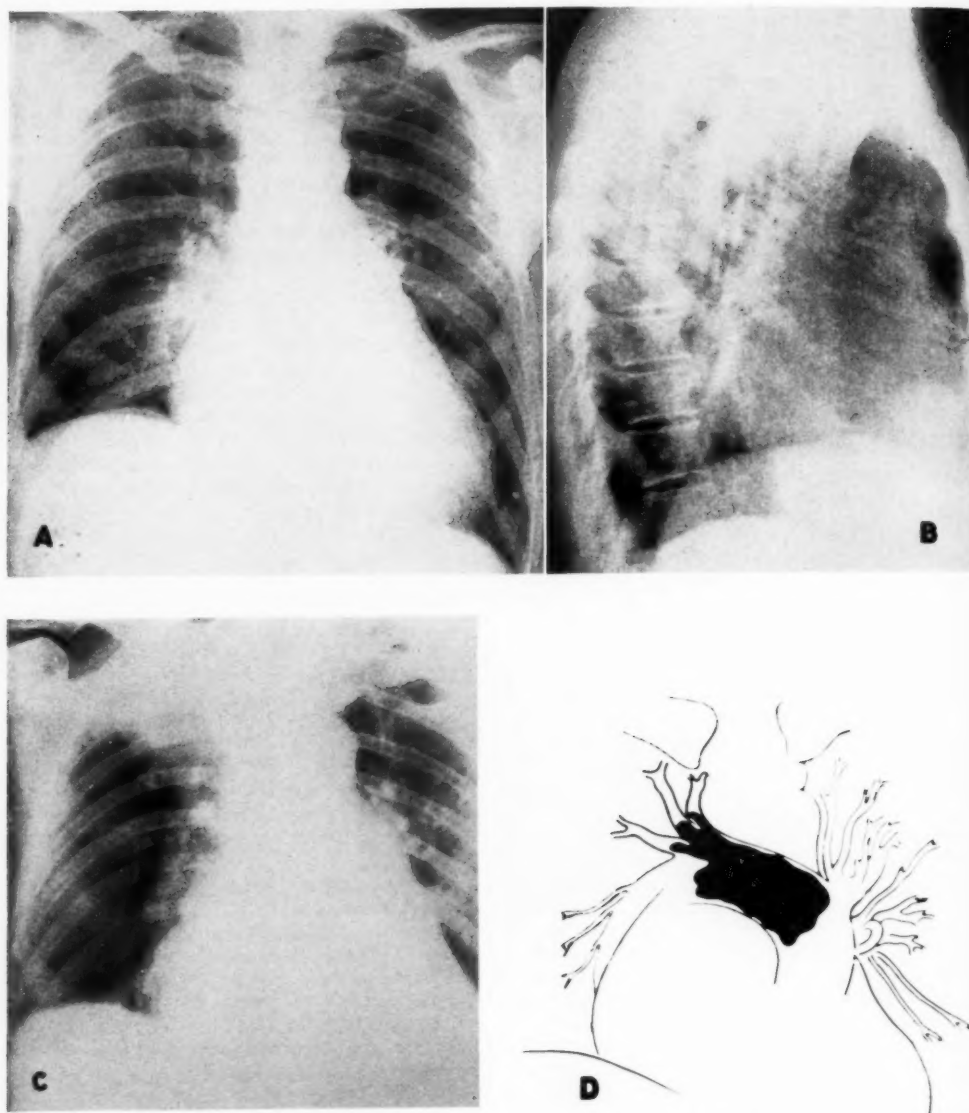


Fig. 5. Case 5: Thrombosis of right pulmonary artery in rheumatic valvular disease.

A and B. Postero-anterior and lateral views, seven days before death and before clinical development of thrombosis. The heart is enlarged; the hilar shadows are prominent; and the lung fields are symmetrically vascular.

C. Anteroposterior view on day of demise shows infarct at the apex of the right upper lobe and decreased vascularity of the remainder of the right lung.

D. Diagram showing position of thrombi.

was found at postmortem examination. Avascularity of the right lung is due to the thrombosis of the right main pulmonary artery.

CASE 67: M. W., a 47-year-old white housewife was admitted to the hospital because of shortness of

breath, ascites, and peripheral edema. The patient had been well until a year before entry, at which time she noted the onset of progressively severe exertional dyspnea and peripheral edema. Initially

<sup>1</sup> Case 35,432. *New England J. Med.* 241: 669-673, Oct. 27, 1949.

she responded to measures designed to combat the manifestations of cardiac failure, but six weeks prior to entry she became refractory to digitalis and diuretics. There had been no orthopnea or hemoptysis.

Examination revealed slight cyanosis, distention of the neck veins and of the veins of the upper chest, arms, and forehead. Blood pressure was 115/100. The chest was clear. The heart was enlarged, with a diastolic murmur at the apex and left lower sternal border, a thrill, and a loud  $P_2$ . Hepatomegaly, ascites, and peripheral edema were present.

Hemoglobin was 16 gm. per cent; total protein 5.16 gm. per cent; vital capacity 2.1 liters (63 per cent of normal).

There was little change in the patient's condition during her hospitalization. On the sixth day an abdominal paracentesis produced 3,900 c.c. of slightly cloudy, straw-colored fluid. Electrocardiograms on three occasions showed evidence of right axis deviation, normal rhythm, and a rate of 80 to 95. The patient complained of tenderness in the legs a few days before discharge, but an examination for thrombophlebitis was considered negative. She was discharged on the thirty-fourth day, and three days later died suddenly at home.

*Roentgen examination* showed the peripheral lung fields to be symmetrically avascular. The right interlobar artery was enlarged, as was the right ventricle. The impression upon the barium-filled esophagus below the aortic indentation may be the result of pressure by the enlarged right pulmonary artery (Fig. 6).

*Postmortem Protocol* (pertinent findings): *Bronchial lymph nodes* are dark red, tense and congested, and measure up to 1.5 cm. in diameter. There are early infarcts in the *right lower and left upper lobes*. The intimal surfaces of the pulmonary artery are smooth in the main stem and the two major branches. In the secondary and tertiary branches there is definite atherosclerosis. Lying in the left *pulmonary artery*, but not occluding it entirely, is a soft but firm dark red and tan thrombus which extends into and occludes several of the smaller branches supplying the left upper lobe. The thrombus is softly adherent to the wall and is teased away with difficulty. It measures approximately 7 cm. in length; its greatest diameter is about 1.3 cm. A similar thrombus measuring 5 cm. in length and 0.8 cm. in greatest diameter lies in the distal portion of the pulmonary artery and extends into and occludes several small branches leading to the right lower lobe. Both thrombi occlude the vessels supplying the portions of the right lower and left upper lobes described as infarcted. The thrombi are thought to be not older than one week. The outstanding finding at autopsy was gross occlusion of the tertiary branches of the right and left pulmonary arteries. Apparent gross occlusion is proved microscopically to be due to old thrombi which have been recanalized with a number of pin-point channels.

*Heart:* The wall of the right ventricle measures 7 mm. in thickness; that of the left 12 mm. The right ventricle is three to four times the size of the left. The columnae carneae of the right ventricle are markedly thickened.

*Peripheral Vessels:* The popliteal and pelvic veins show no evidence of thrombosis.

*Comment:* This case of multiple organized peripheral thrombi is included in the series because of the roentgen appearance. The contour of the hilar shadows, the decrease in the apparent number of vascular shadows in the peripheral lung fields, and the clinical history all suggest the possibility of extensive thrombosis in the major branches of the pulmonary arteries. Although at the time of autopsy there were thrombi present in some of the large pulmonary vessels, the pathologist considered them to have formed considerably later than the time at which the chest roentgenogram was taken. Large vessel thrombosis therefore could have played no role in the production of the changes observed on the film.

It is apparent that in a case of multiple peripheral pulmonary arterial thromboses the roentgen appearance of the chest can simulate quite closely that of bilateral thrombosis of the main branches extending into the interlobar arteries.

#### DISCUSSION

In all 5 cases presented the presence of a thrombus in the right, left, or main pulmonary artery was established by post-mortem examination.

A consistent finding in all, which cannot be appreciated on inspection of the post-mortem specimen, is the reduced distention, during life, of the pulmonary vessels distal to the thrombus.

Pulmonary infarcts were present in 4 out of 5 cases.

Thrombosis is more common in patients with pre-existing congenital or acquired heart disease. Where it is of long duration, right heart enlargement and the manifestations of right heart failure may occur.

In those cases where there was enlarge-

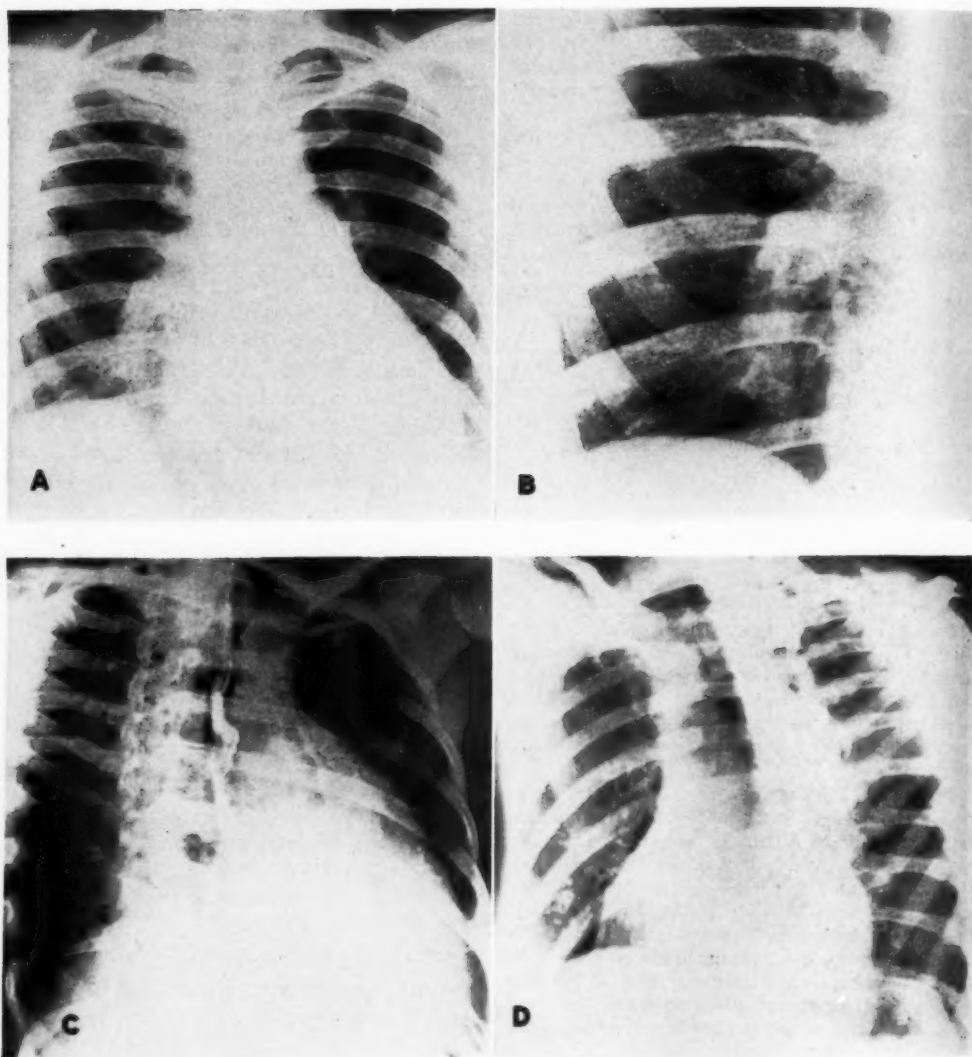


Fig. 6. Case 6: Chronic cor pulmonale resulting from multiple organized thrombi of tertiary branches of pulmonary artery. Roentgenograms made thirty-three days before death.

A. Postero-anterior view showing cardiac enlargement, avascularity of both lungs, and enlarged angular contour of the right interlobar artery.

B. Detail view of the right hilar area showing the altered contour and size of the interlobar artery. The vessels proceeding laterally from it are of diminished caliber.

C and D. Right and left oblique views demonstrate enlargement of the right heart and pulmonary artery. Note the impression upon the barium-filled esophagus below aortic indentation which may result from pressure by the enlarged right pulmonary artery.

See also Fig. 6, E.

ment of the hilus or hili, a thrombus was found at autopsy within the involved vessels, corresponding closely in size and shape to the hilar contour observed on the film. It is apparent, therefore, that the outline of the hilus is essentially that of the thrombus,

with a thin layer of blood flowing around it.

When the distribution of the major vessel thrombosis is such that symmetrically enlarged hilar contours result and the peripheral lung fields are symmetrically avascular, the roentgen differential diag-



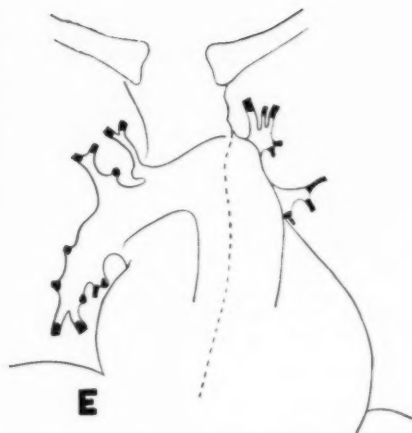


Fig. 6, E. Case 6: Diagram showing position of thrombi.

nosis from such conditions as pulmonary arteriosclerosis (19) and multiple peripheral pulmonary thrombi is usually impossible. When enlarged hilar vessels are accompanied by normal or uniformly increased vascularity of the lung, as in interauricular septal defect, pulmonary thrombosis can be excluded. Should there be an area of relative avascularity, however, pulmonary thrombosis should be considered.

Thrombosis should be considered also when the hilar shadows are decreased in size on one or both sides. In the one case with a small right hilus (Case 1), the description of the distal end of the right main pulmonary artery thrombus is not sufficiently detailed to locate it accurately on the film. It is apparent, however, from the size of the right hilar shadow that any thrombus which is present in the interlobar artery is small and that the obstructing portion of the thrombus lies proximal to the hilus in the main and right pulmonary arteries. When the decrease in the hilar shadows is symmetrical, the differential diagnosis from pulmonic stenosis, with or without tetralogy of Fallot, will have to be made with the help of other information.

The appearance of generalized or localized emphysema may be simulated by the decreased vascularity resulting from thrombosis. At times it may be difficult to dis-

tinguish between the two entities, but in the absence of evidence of collapse of adjacent segments or of ball-valve obstruction, a zone of increased radiolucency in the lungs should arouse suspicion of thrombosis. This area may include both lungs, one lung, or one or more segments.

#### SUMMARY

Thrombosis in the pulmonary arterial tree is more commonly secondary to embolism; less often it occurs *in situ*. Infarction may or may not result. Such thrombi produce alterations in the pulmonary circulation which may be detectable in chest roentgenograms. When the thrombus is located in a major vessel and causes a relatively high degree of obstruction, the following changes may ensue: (1) dilatation proximal to the block, (2) enlargement and alteration in contour of the vessel at the level of the thrombus, and (3) decrease in the caliber of the vessels distal to the thrombus, causing increased radiolucency in the corresponding area of lung.

When multiple thrombi are located in branches of the third and fourth order, a somewhat similar appearance with enlargement of major vessels and avascular lung fields may be observed (Case 6).

In those cases of long duration in which thrombosis produces considerable obstruction, cor pulmonale and eventual right heart failure develop (Cases 1, 5, 6).

Differentiation from other causes of hilar change and alteration in vascular pattern may be difficult.

Five cases of major vessel thrombosis and one case of multiple peripheral thrombi are presented.

NOTE: Since this paper was submitted for publication the following article on this subject has appeared: Carroll, D.: Chronic Obstruction of Major Pulmonary Arteries. *Am. J. Med.* 9: 175-185, August 1950.

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## SUMARIO

## Trombosis de la Arteria Pulmonar: Manifestaciones Roentgenológicas

La trombosis del árbol arterial del pulmón es más generalmente secundaria a embolia, presentándose menos a menudo *in situ*. Puede o no sobrevenir infarto. Esos

trombos producen alteraciones de la circulación pulmonar que pueden ser observables en las radiografías torácicas. Cuando el trombo se localiza en un vaso grande

y ocasiona una oclusión relativamente intensa, pueden ocurrir las siguientes alteraciones: (1) dilatación proximal a la oclusión; (2) hipertrofia y alteración del contorno del vaso al nivel del trombo; (3) achicamiento del calibre de los vasos distales al trombo, acrecentando la radiolucencia de la zona pulmonar correspondiente.

Cuando se localizan varios trombos en las ramas arteriales de tercero y cuarto orden, puede observarse un aspecto algo semejante con hipertrofia de los grandes

vasos y campos pulmonares avasculares.

En los casos muy antiguos en los que la trombosis provoca considerable oclusión, sobrevienen cor pulmonale y por fin insuficiencia del corazón derecho.

Puede resultar difícil la diferenciación de otras causas de modificación hiliar y de alteración del patrón vascular.

Preséntanse 5 casos de trombosis de los vasos mayores y un caso de trombos periféricos múltiples.



## Cardiac Mensuration as Applied to Survey Films (4 × 5-Inch Photoroentgenograms)<sup>1</sup>

LEWIS G. JACOBS, M.D., and HERMAN NUSSBAUM, M.D.

THE ROENTGEN mensuration of heart size has assumed considerable importance medically since the pioneer work of Bardeen (1) and of Hodges and Eyster (2). In general, the problem has been to pick those hearts showing as small a degree as possible of enlargement above true normal. Many methods of measuring the heart shadow have been proposed, and most of them may be classified into three groups: those in which some diameter or diameters are used, those in which an area estimation is used, and those in which a volumetric reconstruction is used. It is particularly noteworthy that no one has attempted to see how accurately the shadow measurement can be reproduced by the same or by another observer; either it is tacitly assumed, and incorrectly so, that the results are reproducible, or the error involved is grossly underestimated.

The standard to which these measurements are compared is usually anthropometric, a combination of height and weight being the most common, although various other measurements have been proposed, such as the chest diameter. A good many writers have been very emphatic that the more complex methods, both theoretically and practically, have given a sharper separation of the normals and abnormals. This belief, however, has never been proved by sound statistical evidence, and what evidence there is would seem to indicate that the difference in resolution is slight, if it exists at all. The correlation coefficients have been but little higher, while the error, or perhaps it would be better to say the difference, between successive measurements on the same film by the same or by a different observer becomes

excessive. The very general failure to evaluate this last factor is the basis for the mistaken confidence of many in complex and difficult methods of measurement.

In addition to these factors, there is a certain degree of "natural overlap"; that is, certain hearts are small enough before they become diseased that considerable enlargement must take place before they exceed the average, and conversely other hearts are naturally relatively large, even exceeding what we choose to call the "normal," although no disease is present. As the range of normal size variation is increased to include this second group, more and more of the first group is also included; or as the range is decreased to exclude the first group, more and more of the second is also excluded, so that some error, one way or the other, is unavoidable. For most of the existing formulae the overlap is in the vicinity of 5 per cent of cases.

The problem as applied to survey and photoroentgen studies differs somewhat from that of precision measurement. In the first place, the accuracy will be considerably less in any photoroentgen study, since the short target-screen distance will increase the magnification-distortion of the heart shadow in a relatively unpredictable manner. In the second place, the accuracy required is less, since after all we are only sorting out cases for further and more complete clinical study; the inclusion of a few normals is not serious, provided the proportion be not too large. And in the third place, the necessity for reading a large number of films in a relatively short time makes it essential that the method be convenient, since it is hardly possible to apply complicated measurements under

<sup>1</sup> From the Department of Radiology, Veterans Administration Hospital, Oakland 12, Calif. Sponsored by the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration. Presented at the Thirty-sixth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 10-15, 1950.

TABLE I: DIFFERENCE IN MEASUREMENTS (mm.) BY TWO AUTHORS, COMPARED TO TRANSVERSE DIAMETER (14 X 17-INCH FILMS)

T.D. Heart	Difference in Measurement (mm.)					
	0	1-5	6-10	11-15	16-20	21-25
91-100	1	5	0	0	0	0
101-110	7	20	4	0	0	0
111-120	5	28	4	5	1	0
121-130	5	32	6	6	2	0
131-140	4	23	7	5	3	0
141-150	2	12	0	2	2	1
151-160	0	3	1	1	0	0
161-	0	0	1	0	0	0
TOTAL	24	123	23	19	8	1

TABLE II: DIFFERENCE IN MEASUREMENTS (mm.) BY TWO AUTHORS, COMPARED TO TRANSVERSE DIAMETER (4 X 5-INCH PHOTOROENTGENOGRAMS)

T.D. Heart	Difference in Measurement (mm.)							
	0	1	2	3	4	5	6	7
21-25	2	2	0	1	0	0	1	0
26-30	26	21	9	2	0	0	0	0
31-35	42	21	9	4	4	4	1	0
36-40	17	16	5	2	1	2	0	1
41-45	0	3	1	0	0	0	0	0
46-50	0	0	0	0	0	0	1	0
TOTAL	87	63	24	9	5	6	3	1

these conditions. Taking all of these factors into account, we have made an experimental study by statistical methods to determine what might be a suitable standard.

Two hundred adults—134 men and 66 women—without clinical evidence of heart disease form the basis of this study; they were either hospital employees or patients with other than cardiac disease, but all were examined clinically. For each a 14 X 17-inch and a 4 X 5-inch film were obtained at a fairly close interval. All films were measured independently by each author, and record was made of the transverse diameter of the heart, that of the chest at the apex of the heart, and the greatest length of aerated lung on the right measuring from the apex of the chest to the highest point of the diaphragm. The age was also noted for each person. In a previous publication (3) the validity of size prediction with these measurements was proved for 14 X 17-inch films; and they are more convenient than height and weight for this type of work.

Since so little attention has been given to the reproducibility of the measurements, the results of a comparison between the

measurements of the two authors is given in Tables I and II. In each case the difference was recorded entirely on the basis of independent measurements; no attempt was made to make the measurements agree other than ordinary care in the performance of the work. Only 198 cases are recorded; through an error two sets of films were shipped out before one author could make measurements on them. It is noticeable that a difference of 7 mm. appeared in the pair of measurements on one photoroentgenogram, and one of 25 mm. in the pair on one 14 X 17-inch film. If this seems unbelievable, stop to think how hard the decision on occasional films as to where the heart border actually is! It would therefore appear that excessive refinements in cardiac measurement are deluding, inasmuch as measurement of even so simple a thing as a diameter is subject to a significant error, one which may well invalidate a conclusion, enlarged or not enlarged, in any individual case. Certainly for a sorting procedure, excessive refinements appear absurd.

Using the conventional methods for multiple linear correlation, regression equa-

tions were made for the prediction of heart size for both the 14 × 17-inch film measurements and the 4 × 5-inch film measurements, and the standard errors of estimate were calculated. The equations were:

14 × 17:

$$\begin{aligned} \text{T.D.} = & 0.52 (\text{chest diameter}) - 0.037 \\ & (\text{lung length}) + 0.09 (\text{age}) \\ & - 18.62 (\text{standard error of estimate, 12.26 mm.}) \end{aligned}$$

4 × 5:

$$\begin{aligned} \text{T.D.} = & 0.36 (\text{chest diameter}) - 0.19 (\text{lung length}) \\ & + 0.096 (\text{age}) + 12.57 \\ & (\text{standard error of estimate, 2.33 mm.}) \end{aligned}$$

These formulas show little difference in the slopes of the regressions from those previously developed on 500 14 × 17-inch films, as well as between themselves; the variations might well be chance in origin. This would suggest that the slope of the regression is not really altered by the change in film size (this might well be anticipated from considering the facts involved), and the results might apply to other sizes of survey film, at least tentatively until an actual test can be made. The individual predictions were then calculated, and compared with the measured transverse diameter; also the cardiothoracic index was calculated and compared. Sixteen normal cases were segregated as "enlarged" by one or more of these methods; they are tabulated as follows:

1. By 14 × 17 film, formula.....	5
2. By 4 × 5 film, formula.....	6
3. By 4 × 5 cardiothoracic ratio.....	7
4. By both 1 and 2.....	5
5. By both 1 and 3.....	2
6. By both 2 and 3.....	3
7. By all three.....	2
8. By 14 × 17 cardiothoracic ratio.....	10
9. By 8 and one of the other measures.....	4

In deciding that a heart was "abnormal," the range of two standard errors was chosen, representing a 4.5 per cent probability of chance occurrence.

It is evident that from 2.5 to 3.5 per cent of "normals" are segregated as "abnormals" by any one of the methods. Therefore, even the cardiothoracic ratio on

4 × 5-inch films would be acceptable, since perhaps one in a hundred patients would be unnecessarily chosen for clinical examination, an error reasonably tolerable in view of the many other sources of error in this type of work.

As a further test of this matter, the correlation formula for prediction of transverse diameter of the heart from transverse diameter of the chest was worked out for the same set of 4 × 5-inch films. The result was:

$$\text{T.D.} = 0.4 (\text{T.D. chest}) + 1.3 (\text{standard error of estimate, 3.6 mm.})$$

Using the range of two standard errors as before, we find that the difference between 0.5 (T.D. chest) and 0.4 (T.D. chest) + 1.3 + 7.2 is trifling. For the usual range of chest sizes, 60 to 90 mm., the predictions by the first fall between 30 and 45 mm. and by the second between 32.5 and 44.5 mm. It is true that the correlation formula using three variables has a coefficient of correlation of +0.622, while that using the transverse diameter of the chest alone has one of +0.544, so that the degree of determination is about 10 per cent poorer, but this is hardly important in a sorting procedure where extremes of accuracy are unnecessary.

We have made no test of the number of abnormals that might be falsely included in the normal range; that this omission does not affect the conclusion is attributed to two facts already mentioned: first, that some abnormal hearts fall in the normal range of x-ray size with even the most meticulous methods; second, that if enlargement is present, the technic of obtaining a 4 × 5-inch film will tend to magnify it rather than minimize it. We also omit a consideration of cardiac shape, since in general this can be evaluated on the same basis as in ordinary roentgenograms of the chest; its importance should not be overlooked.

#### CONCLUSIONS

Evidence has been offered to show that the cardiothoracic ratio (assuming that a



heart is enlarged if it exceeds half the chest diameter at the apex) is an adequate basis for sorting  $4 \times 5$ -inch photoroentgen survey films, and probably smaller sizes as well. The use of the cardiothoracic index on  $14 \times 17$ -inch films is of questionable value, since it tends to sort out too many normals for study. Since there are certain known inaccuracies in the employment of this measure, it must not be considered adequate for more precise clinical work; the errors are unimportant only because, first of all, they approximate in size the

known error in measuring the diameters on small films, and second, because the procedure is intended for sorting only.

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#### SUMARIO

##### La Medición Cardíaca Aplicada a las Radiografías de Encuesta (Fotorroentgenogramas de $10 \times 12.5$ Cm.)

Las películas fotorroentgenográficas ( $10 \times 12.5$  cm.) y las de  $35 \times 42.5$  cm. de 198 personas sin signos clínicos de afección cardíaca fueron estudiadas independientemente por los dos AA., con mira a predecir el tamaño del corazón. Los resultados denotan que hasta las mediciones más sencillas son susceptibles de errores significativos, y que, por lo tanto, los excesivos refinamientos de la técnica mensural, sobre todo para fines de encuestas, son innecesarios y hasta pueden conducir a error.

La razón cardio-torácica (dando por sentado que el corazón está hipertrofiado si excede en la punta de la mitad del diámetro torácico) resultó ser una base adecuada para sortear las radiografías de  $10 \times 12.5$  cm. El empleo de dicha razón en las radiografías de  $35 \times 42.5$  cm. es de valor dudoso para ese fin, pues tiende a excluir demasiadas películas normales del estudio. Por otro lado, tampoco debe considerarse adecuado para labor clínica precisa, por entrañar ciertas inexactitudes conocidas.



## Solitary Pulmonary Necrosis

### A Comparison of Neoplastic and Inflammatory Conditions<sup>1</sup>

RUSSELL WIGH, M.D., and FREDERICK R. GILMORE, M.D.

THE FIRST roentgenologic report indicating the presence of pulmonary excavation in bronchogenic carcinoma can be attributed to Carman (1) in 1921. Since then many authors (2-9) have discussed its occurrence and have given descriptions of the cavities. In most cases the presence of necrosis within a neoplastic mass or the suppuration associated with neoplasm is considered as roentgenologically undifferentiable from simple lung abscess, particularly when a solitary cavity occurs.

A considerable portion of the literature antedates the use of antibiotic drugs and chemotherapeutic agents, covering a period when excavation in tumors was infrequent when considered against the volume of patients with pulmonary abscess from inflammatory conditions. This long-standing association in our minds of necrosis with the concept of infection predisposes against the consideration of neoplasm. Apparently, however, a statistical reversal of these two conditions has taken place, so that it is of great importance, particularly with reference to patients in the latter decades of life, to consider the probability of necrosis within a pulmonary parenchymal lesion as being as likely due to neoplasm as to lung abscess.

Even though the stated incidence of roentgenologically detectable necrosis in pulmonary carcinoma is relatively low—approximately 10 to 12 per cent (4, 10)—it assumes considerable significance in view of the frequency of carcinoma. One must not, therefore, be content with the roentgen diagnosis of benign lung abscess in a patient over forty years of age. Bronchoscopy without aspiration of the main bronchus to the involved pulmonary area will be more frequently negative than

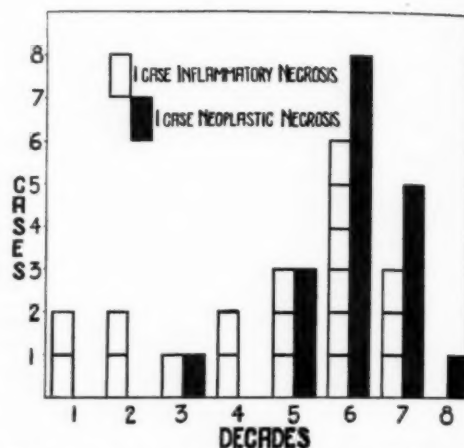


Chart I. Age distribution of inflammatory abscesses and neoplastic necrosis.

positive, since many of these tumors are peripheral in location. Since endobronchial aspiration for cancer cells (11, 12) can be positive in an extremely high percentage of cases of bronchogenic carcinoma, it should be offered every patient with a lesion in which the possibility of neoplasm is considered. Such studies, however, are frequently performed only after roentgenologic consultation and may be neglected if it is not realized that the frequency of single abscesses due to carcinoma actually is greater than of those due to inflammatory lesions in the age group beyond forty years. Reliance should not be placed on serial studies alone, important as they are. At this institution it has been noticed that many inflammatory abscesses require longer than three weeks to resolve, and certainly three weeks should constitute a maximum period of observation only.

To indicate the frequency of lung ab-

<sup>1</sup> From the Department of Radiology, Jefferson Medical College Hospital, Philadelphia, Penna. Presented at the Thirty-sixth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 10-15, 1950.

TABLE I: SOLITARY NEOPLASTIC NECROSIS, ABSCESSES, AND ABSCESS-LIKE LESIONS IN THE LUNGS

	In Patients Less than Forty	In Patients Forty or Over	Total	Total Over Forty
<b>Intraneoplastic Necrosis</b>				
Within bronchogenic carcinoma	0	11	11	
Within metastatic uterine carcinoma	0	1	1	
Within Hodgkin's granuloma	1	0	1	
			13	12
<b>Extraneoplastic Necrosis</b>				
Abscess distal to bronchogenic carcinoma	0	5	5	
<b>Total neoplastic cases</b>			18	17
<b>Inflammatory Abscesses</b>				
Secondary to foreign body, surgery, pneumonia (including Friedländer's)	5	10	15	
Due to infarct	1	1	2	
Related to bronchiectasis	1	1	2	
<b>Total inflammatory cases</b>			19	12
<b>Other Abscess-like Lesions</b>				
Pulmonary cysts (communicating)	5	2	7	
Postpneumonic pneumatocele	1	0	1	
Undiagnosed	0	4	4	

cess, particularly before 1943, one may cite several reports in the literature. Sweet (13) collected 120 cases of lung abscess at the Massachusetts General Hospital between 1938 and 1943; Janes (14) found 106 cases between 1933 and 1940 in the Toronto General Hospital. Such large groups of purely inflammatory abscesses far exceeded the possible numbers of necrotic carcinomas for those periods. In 1935, Graham (15) indicated that 10 per cent of all lung abscesses were related to bronchogenic carcinoma.

For the purposes of the present study, the roentgenograms of all patients admitted to the clinics or wards of Jefferson Medical College Hospital (ward bed capacity, 452) during the four-year period from 1946 to 1950, showing a single encapsulated area of pulmonary radiotranslucency, have been reviewed. Patients with tuberculosis were excluded from the analysis. During this period, 19 single lung abscesses of inflammatory origin were detected, while there were 18 proved malignant neoplasms associated with a single necrotic cavity. When the age groups of these patients are considered, the preponderance of neoplastic necrosis after forty is greatly emphasized (Chart I). The age distribution of patients having

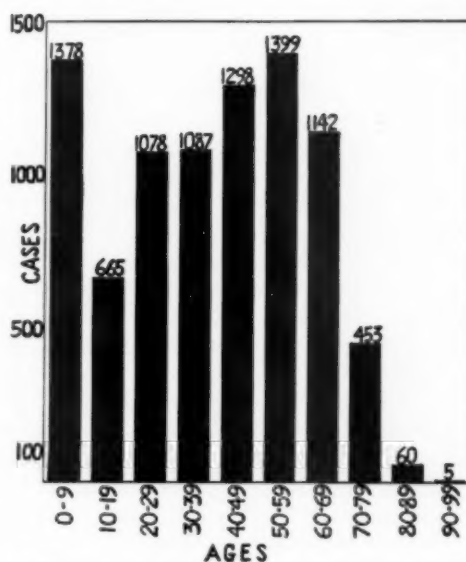


Chart II. Age distribution, by decades, of 8,365 consecutive patients having conventional chest roentgenograms, Jefferson Hospital, 1946-50.

chest roentgenograms is charted graphically for comparison with other institutions (Chart II). Undoubtedly, more cases of excavation would have been identified, reflecting a closer agreement with postmortem studies than is indicated by the above statistics, had Bucky studies or planigrams been obtained in at least the 160



Fig. 1. Solitary area of parenchymal necrosis distal to an obstructing endobronchial carcinoma.

patients with bronchogenic carcinoma. Necropsy examinations indicate that from 30 to 50 per cent of bronchogenic carcinomas are necrotic (16-18). Usually, however, at this institution, a cytologic diagnosis is made by bronchial aspiration methods and Papanicolaou staining, so that further roentgen studies are not always obtained.

In localities where microscopic studies of bronchial saline washings cannot be readily obtained, further roentgen observations together with the age group distribution should aid in the differential diagnosis or, at least, should reduce the period of observation before transfer of the patient to a place where this type of procedure is available. In 90 per cent of our cases of bronchogenic necrotic carcinoma a positive endobronchial cytologic smear was obtained. Actually a high percentage is to be expected, since the tumors are communicating freely and the necrosis alone will permit ready discharge of tumor cells. Herbut (19) obtained 88 per cent positive studies with the Papanicolaou technic in his last 410 bronchogenic carcinomas.

On the basis of probability alone a patient over forty years of age (Table I) with a non-tuberculous single cavity is more likely to have a neoplastic abscess than an inflammatory one.

#### ROENTGENOLOGIC CONSIDERATIONS

It seems desirable to evaluate the roentgen features which may help to strengthen the opinion that one is dealing with cancer.

During the four-year period under consideration, solitary areas of necrosis or pulmonary radiotranslucency were found in 49 cases. These cases are classified in Table I. The problem of differential diagnosis is actually that of differentiating lung abscess from necrosis within a tumor. The pulmonary air cysts are simply disposed of by indicating that those which are extremely large are very characteristic; they displace the mediastinum contralaterally and present no problem of differentiation from cancer. The smaller ones of this group had very thin, smooth walls and produced no surrounding pulmonary reaction except for a curved displacement of the near-by vessels. An infected cyst may, of course, simulate lung abscess and thus enter into the problem of differentiation from cancer. The characteristics of infected lung cysts have been summarized by Rigler (20) and their differentiation from tumor has been considered by Pugh (21).

The possibility of attributing solitary necrosis distal to an obstructing tumor to a benign inflammatory process is slight, since the obstructive endobronchial nature of the lesion is usually made obvious by the presence of atelectasis (Fig. 1). In all 5 of our cases of this type there was atelectasis; in several, an entire lobe was airless. Since all physicians are aware of the causative relationship of neoplasm and atelectasis, it is unlikely that these cases will be unrecognized and improperly managed despite the fact that the necrosis is solitary and, therefore, suggestive of benign abscess. Further, the endoscopist usually can see these tumors, since they are close to the hilus. Therefore, we will pro-

ceed with an analysis of the cases of necrosis actually within the tumor and compare or contrast the findings with those of benign inflammatory necrosis.<sup>2</sup>

**Mass:** The presence of a discernible mass in the event of necrosis within a tumor is a most striking feature and presents a different picture than does lung abscess; a distinct mass was present in 8 of our 13 cases. This is well defined tumor, circumscribed, with no evident surrounding reaction (Fig. 2). These tumors varied from 7 to 15 cm. in diameter, in some instances involving an entire lobe and bulging into or crossing a fissure to another lobe. One usually notes, then, neoplasm surrounding an area of radiotranslucency. In the inflammatory abscesses the peripheral density could be described in 13 instances as poorly delineated or gradually fading. In but 4 cases was it moderately well defined or well defined (actually simulating cyst). In 2 cases the surrounding pneumonia was segmental and limited by fissures.

**The Cavity:** The cavities within the 13 cancers varied from 2 cm. to 10 cm. in diameter. There was no relationship between the size of the cavity and the size of the tumor. Actually, in 4 cases the tumor was almost completely evacuated, while in others the amount of necrosis was small in relation to the tumor size. The cavities were most frequently centrally placed (Fig. 2). In the purely inflammatory lesions the cavities varied from 1 to 7 cm. in diameter. They bore no real relation to the extent of the peripheral density, but generally they were smaller than the neoplastic cavities. Although more than

half were centrally placed, there were proportionately more which were eccentric than in the tumors. The predominantly central position of neoplastic cavities corresponds with the findings of Kirklin and Paterson (6).

**Fluid Level:** Fluid was present in 10 of the 13 cases of necrotic neoplasm and in 16 of the 19 abscesses.

**The Wall:** The thickness of the neoplastic wall varied, of course, with the amount of necrosis, the variation being from 4 mm. to 5 cm. The interior surface of the wall was never perfectly smooth; the less irregular linings were found in cases in which excavation was the greatest. In only 2 cases were the walls sufficiently regular and thin to suggest a cyst (Fig. 3). In the remaining 11 cases the cavities ranged from those of merely an irregular character to those in which the inner surface was actually nodular or indeed made the cavity appear multilocular (Fig. 2A<sup>2</sup>). Such nodules are described as producing a stalactite or stalagmite appearance (5); they were found in 6 instances.

In abscess, it is difficult to speak of a "wall." Where measurable it varied from 1 mm. to 1 cm. but in most instances was not definable. The inner lining was smooth in 11 instances, irregular in 5, nodular or shaggy in 2, and in 1 instance the cavity was too small to permit classification of its lining.

**Fissures and Pleura:** In 4 cases the neoplastic mass crossed or bulged into another lobe (Fig. 4). It need not conform to a segmental or lobar distribution. This was not a feature of inflammatory lesions.

In only 5 cases did there seem to be a related pleural reaction to tumor; among the inflammatory lesions, on the other hand, there were 11 cases in which the homolateral costophrenic angle was obliterated or the lateral pleura or fissural pleura was thickened in relation to the disease process.

**Other Lesions:** In none of the neoplastic cases were there any other pulmonary lesions, except metastases, of a character which would either help in the differential

<sup>2</sup> Most of us may be more familiar with the finding of multiple areas of necrosis behind an obstructing lesion; bronchogenic carcinoma does produce roentgenologic evidence of pulmonary necrosis with much greater frequency than might be judged by the above analysis, which includes only solitary excavation. In such instance the differentiation between an inflammatory and neoplastic lesion is much more readily made either by bronchoscopic biopsy or bronchographic delineation of the tumor. There were 20 such cases in this 4-year survey, which included 160 cases of proved bronchogenic carcinoma. Interestingly enough, in 2 of these 20 there were not only multiple areas of cavitation in the atelectatic lung but the obstructing carcinoma itself was excavated.



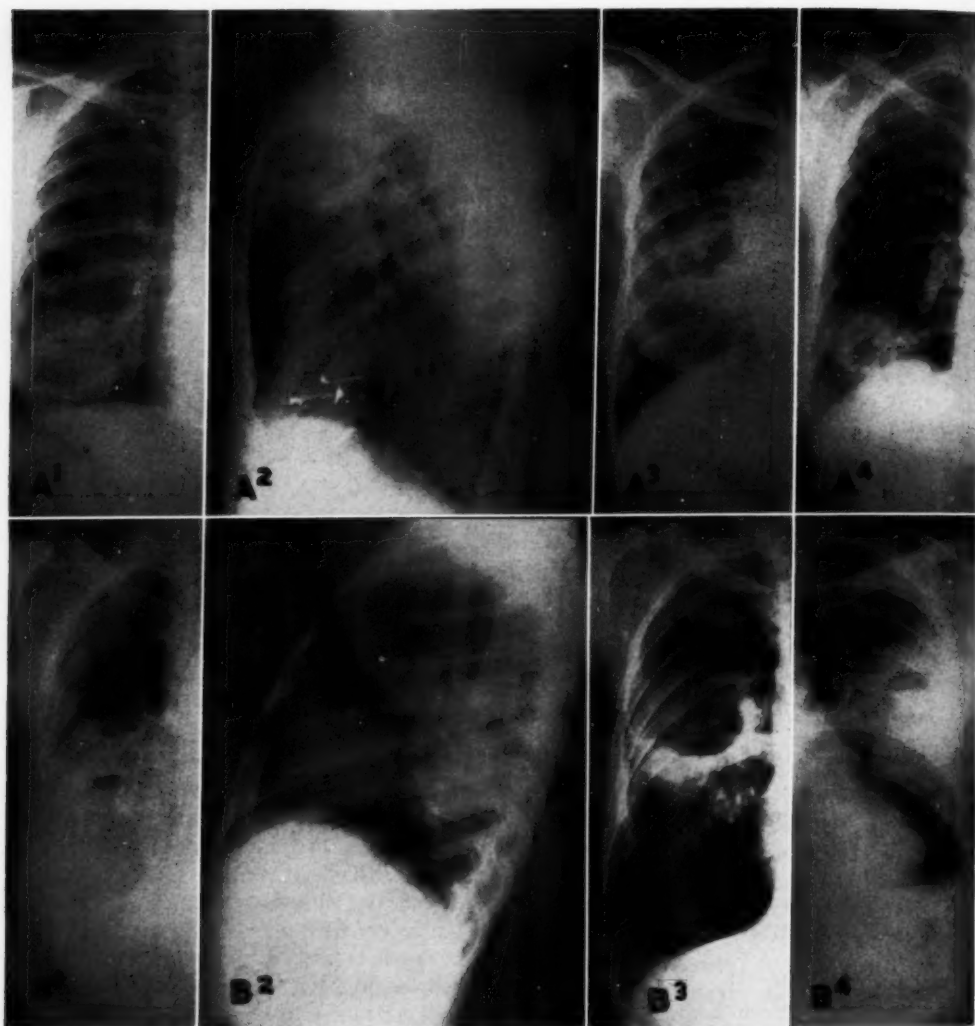


Fig. 2. A<sup>1</sup> and A<sup>2</sup>. Examples of necrosis within bronchogenic carcinoma. A<sup>3</sup>. Necrosis within Hodgkin's granuloma. A<sup>4</sup>. Necrosis within metastatic squamous-cell carcinoma of the cervix.  
B<sup>1</sup>-B<sup>4</sup>. Benign lung abscesses.

diagnosis or add another problem. In the inflammatory group, however, there were 7 cases in which there were other inflammatory changes outside the area of specific interest.

*Atelectasis:* In only 1 case of necrosis within a tumor was definite atelectasis present, and in this instance the tumor was so large that not only could it be seen bronchoscopically but it was surgically proved to reach the chest wall. In another

case the presence or absence of a minor degree of collapse was equivocal. Since most of these tumors are peripheral in position, one is not to expect atelectasis as a prominent feature. In the inflammatory lesions a slight degree of atelectasis was present in 2 instances.

The positions of the trachea, pulmonary artery, mediastinum, and diaphragm,<sup>3</sup> and

<sup>3</sup> In 1 case of bronchogenic carcinoma, the homolateral diaphragm was paralyzed.



Fig. 3. Excavating neoplasm with thin wall.

the size of the thoracic cage merely reflected the above observations.

**Metastasis:** Mediastinal lymph node enlargement was present in 4 cases of bronchogenic carcinoma and was primarily present in the case of Hodgkin's granuloma. In another case of carcinoma there was an area of metastasis in a rib.

Only one instance of mediastinal node

enlargement was observed in the inflammatory group. This was secondary to a carcinoma of the esophagus.

**Lymphangitic Peripheral Spread:** In only 1 case was lymphangitic peripheral spread thought to be present, progressing peripherally from the tumor (Fig. 5).

#### ROENTGENOGRAPHIC PROCEDURES

Lateral chest examinations helped localize the lesion, demonstrate its circumscribed nature, and indicate its pleural relationships. Bucky exposures were mostly confirmatory but helped in a few instances to delineate the excavation and bring out wall detail more critically.

In only 1 of the neoplastic cases was body-section radiography employed, demonstrating that the cavity within a tumor reaching the chest wall was continuous with the endobronchial mass. Bronchography was performed in a single instance, but the oil did not enter the tumor area. As mentioned before, it is probable that a larger number of Bucky and planigraphic

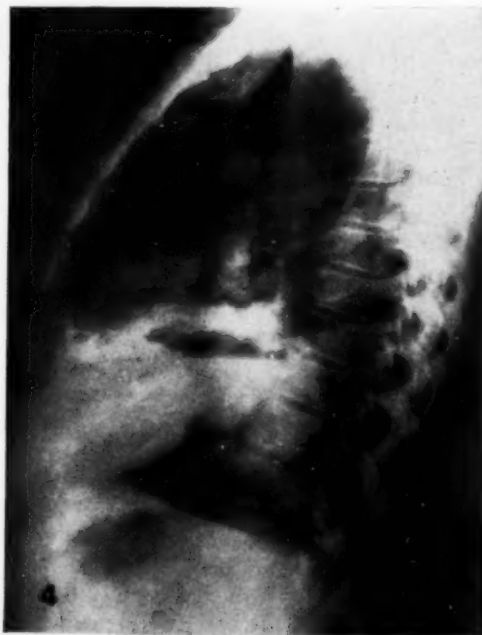


Fig. 4. Neoplastic mass crossing fissure and occupying portions of two lobes.



Fig. 5. Necrotizing bronchogenic carcinoma with peripheral lymphangitic spread suggested.

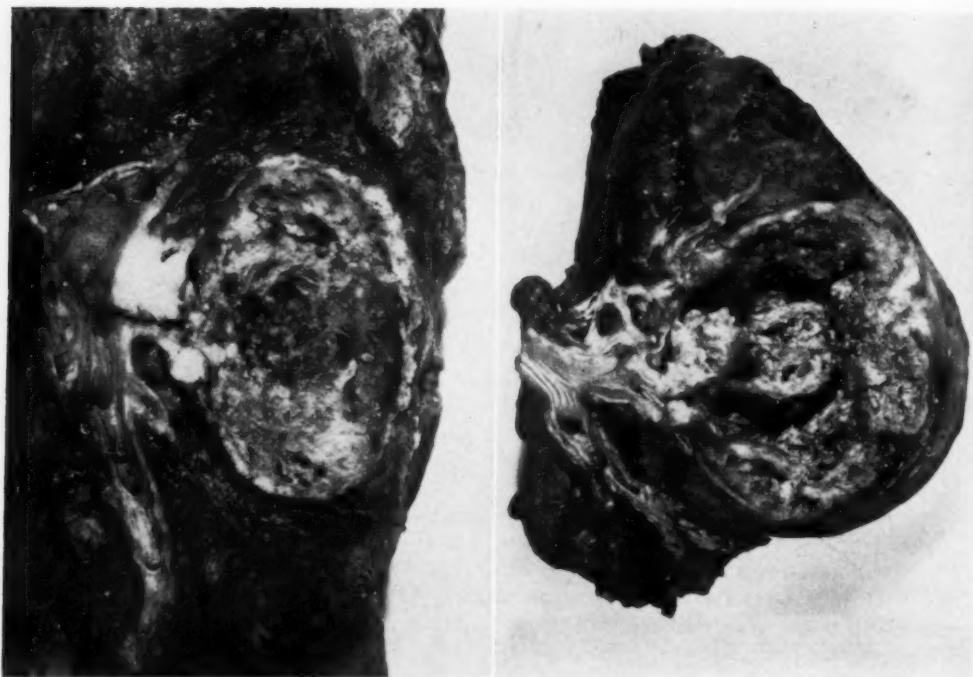


Fig. 6. Lung specimens showing necrosis within bronchogenic carcinoma.

studies would have demonstrated more cases of necrosis.

The clinical reliance on cytologic diagnosis by the Papanicolaou staining of the bronchial saline washings reduced the requirement of special roentgenographic procedures. This was reflected by the fact that bronchograms were obtained in 11 of the inflammatory group—in other words, further study was requested by the various services after negative aspirations were obtained. In 8 of these the affected bronchopulmonary segments were identified, but in only 1 did the opaque medium enter the abscess. In the other 2 the procedure was unsuccessful.

#### DISCUSSION

It is not felt that tuberculosis was a significant problem in this study of single areas of lung destruction. The fact that only single cavities were considered in itself excludes a good portion of the cases of tuberculosis. The single tuberculous cav-

ity infrequently contains fluid; it is usually apical, and there are most frequently areas of exudative disease or tubercles elsewhere (3). When abundant drainage occurs, tubercle bacilli should be found in considerable numbers (22). Further, when tuberculosis reaches the cavity stage, evidence of the disease is usually present in both lungs (4).

In the four-year study there were only 2 cases of unilateral tuberculosis suggestive of abscess in which the organism was not readily found. One six-month-old infant had a small central cavity in a large area of consolidation; the gastric washings were negative. Postmortem study proved the presence of a tuberculous pneumonia. In the second patient, a 51-year-old woman, there was a cavity measuring 4 cm. in diameter; it was in an upper lobe, was smooth and thin-walled, contained no fluid, and there was little surrounding disease. The sputum and gastric washings were negative, but a positive culture was ob-

tained from saline washings of the bronchus of the affected lobe. Possibly one or more of the 4 undiagnosed cases were tuberculous.

Because of the distinct character of excavating neoplasms, some comment is warranted concerning their histopathology and general location. Among the primary bronchogenic carcinomas, 10 were of the squamous-cell variety, either of a keratinizing type or of intermediate grade. The eleventh was a highly undifferentiated epithelial carcinoma. In one large post-mortem series (16), only 40 per cent of all the bronchogenic carcinomas were found to be of the squamous-cell variety. It is more than chance, then, that accounts for excavation in our group, which was so predominantly squamous.

Koletsy found that squamous-cell carcinoma usually begins distal to the bifurcation of a main-stem bronchus, thereby differing from the small-cell type and the adenocarcinoma, which as a rule are more central in location. The predilection for a peripheral site is also attested by the finding that in 8 of our 11 cases of primary bronchogenic carcinoma, the bronchoscopist could see no endobronchial mass (Fig. 6). In 1 case a small papillary non-obstructing mass was observed, from which a moderate-sized extrabronchial intraparenchymal tumor arose. In 2 others, non-obstructing lesions could be seen, but the tumors grew peripherally to such extent that they reached the chest wall; in 1 of these the tumor cavity was broken into during the process of thoracotomy.

The more central neoplasm, squamous or otherwise, producing a single area of suppuration, most frequently does so by first causing obstructive atelectasis peripheral to the mass. The bronchoscopist could visualize tumor in 4 out of the 5 cases in this group. In all of these cases atelectasis was demonstrable. Actually this occurrence of obstruction with a single distal region of radiotranslucency is unusual. More frequently, multiple bronchiectatic cavities or several abscesses will be seen (see footnote, page 711). But it is

the solitary cavity that may suggest that the lesion is a benign inflammatory one if the obstruction is not appreciated radiologically or clinically. Furthermore, a *negative bronchoscopic examination, indicating the absence of a central obstructing lesion, may lead to the dangerous inference that a single cavity is benign.*

#### SUMMARY AND CONCLUSIONS

Although in 22 per cent of 160 cases of bronchogenic carcinoma, routine roentgenographic procedures demonstrated single or multiple abscesses, in 10 per cent of the total cases a solitary cavity was found. Since a solitary excavation has usually suggested a benign abscess, a statistical criterion was sought to establish the probability of either simple abscess or malignant neoplasm as accounting for it.

It was found that a statistical reversal has been occurring for the ratio of frequency between solitary necrosis within or from pulmonary neoplasm, especially bronchogenic carcinoma, to that of lung abscess. Apparently this is due to the use of antibiotics and chemotherapy prophylactically and during the early stages of infection. At the present time, for all age groups, this ratio can be considered near unity; after the age of forty, however, solitary neoplastic necrosis is 1.5 times more common than benign non-tuberculous abscess. Whenever the differential diagnosis arises, therefore, greater weight should be given to bronchogenic carcinoma, at least after the fourth decade.

Of the many roentgen features analyzed, several emphasize the neoplastic origin of the necrosis and further enhance the probability of correct diagnosis.

In the smaller group, where an isolated cavity is distal to an obstructing endobronchial carcinoma, segmental or lobar atelectasis is present. Atelectasis in benign abscess is rare and when present is of minor degree. Since this is universally recognized, atelectasis usually leads to simple bronchoscopic inspection and in most instances the tumor, being near the

hilus, can be seen. Errors or delays in diagnosis should therefore be minimal.

In the larger group, where the solitary cavity is actually an excavation in the neoplasm, the absence of atelectasis makes the resemblance to abscess of inflammatory origin more pronounced. This similarity together with the past association of necrosis with the concept of infection does produce both misdiagnosis and delay. The roentgen criteria that are suggestive of a necrotic malignant neoplasm rather than simple lung abscess are:

1. Well circumscribed mass.
2. Centrally located cavity.
3. Thick, easily defined wall.
4. Irregular or actually nodular inner wall.
5. Lesion crossing or bulging into another lobe.
6. Absence of parenchymal inflammatory change elsewhere.
- (7. Metastases.)

Since bronchoscopy with cytologic study of the secretions or saline washings of the affected bronchopulmonary area can produce positive evidence of neoplastic cells in as high as 90 per cent of cases of carcinoma, the opinion of the radiologist can be easily confirmed. Some of the cytologically unconfirmed cases may have roentgenologic evidence of cancer metastasis. If in the few remaining unconfirmed cases a trial of medical therapy seems warranted clinically, this should not be continued for more than three weeks in the absence of definite improvement before diagnostic thoracotomy is undertaken.

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#### SUMARIO

##### Necrosis Pulmonar Solitaria: Comparación de los Estados Neoplásicos e Inflamatorios

Antes del empleo ya tan difundido de los antibióticos y las drogas quimioterapéuticas en las etapas tempranas de la in-

fección, solía imputarse a absceso benigno toda excavación pulmonar solitaria. Estudios más recientes indican que, al conside-



rar todos los grupos etarios, es igualmente frecuente la necrosis solitaria asociada a neoplasia maligna, y que, a partir de los cuarenta años, la necrosis neoplásica predomina sobre el absceso simple con una proporción de 1.5 a 1. El problema de la diferenciación de esas dos lesiones reviste, pues, cada vez mayor importancia.

Las cavernas distales a un carcinoma endobronquial obstructor se distinguen del absceso por la presencia de atelectasia segmental o lobular. Cuando la caverna solitaria constituye una verdadera excavación dentro de la neoplasia, la semejanza al absceso es más notable. Las pautas roentgenológicas indicativas de la existencia de necrosis dentro de un tumor maligno son: (1) tumefacción bien circunscrita, (2) cavidad localizada en el

centro, (3) pared espesa y fácil de definir, (4) pared interna irregular o realmente nodular, (5) lesión que cruza o proyecta a otro lóbulo, (6) ausencia de alteraciones inflamatorias en el parénquima en otra parte.

En un porcentaje elevado de casos, puede confirmarse o rechazarse el diagnóstico radiológico mediante la broncoscopia con estudios citológicos. Algunos de los casos que no confirma la citología pueden revelar signos de metástasis. En los pocos casos restantes, una prueba de la terapéutica médica parece estar justificada clínicamente, pero si no se obtiene mayor mejoría, no debe continuarse dicho tratamiento por más de tres semanas antes de emprender una toracotomía exploradora.

#### DISCUSSION

(Papers by Hanelin and Eyler; Jacobs and Nussbaum; Wigh and Gilmore)

**Paul C. Swenson, M.D.** (Philadelphia, Penna.): Drs. Hanelin and Eyler have contributed an interesting paper emphasizing the importance of the x-ray findings in pulmonary embolus without hemorrhagic infarction.

Most of us are prone to associate the diagnosis of pulmonary embolism with sudden death. Thus the discussion of cases of rather long duration is of more than usual interest. There are perhaps more cases of pulmonary embolism occurring on the medical wards than on the surgical wards; yet, in spite of the fact that the incidence of pulmonary embolism as a cause of postoperative death is rather low, it is high enough to be of importance in the differential diagnosis of cardiorespiratory complications following surgery.

We should at all times strive for better techniques so that we may get good detail in the lung fields. This may be difficult in the majority of cases, since many patients are bedfast and films must be made with a portable apparatus. Moreover, various authorities—quoted by the authors—have emphasized the difficulty of distinguishing between an area of over-distention in the lung field due to obstructive emphysema and an area which is devoid of a peripheral vascular pattern, as described in the paper under discussion.

Moreover, some of the patterns of the enlarged hili that have been shown would certainly be considered relatively non-specific. Therefore, in the long-standing cases one must be careful to have the three associated findings: (1) enlarged right heart, (2) peculiar hilar shadows, and (3) paucity

of peripheral lung findings. Then, with a careful clinical correlation, the diagnosis can in most cases be called definitive. This at times difficult differential diagnosis should only serve as a challenge for us all to do better work. I congratulate the authors for having again given us a stimulus in this respect.

In regard to the paper of Drs. Jacobs and Nussbaum, I must say I admire their patience and thoroughness in the analysis of their findings. It is of interest that the margin of error as they compute it is less in the case of the smaller film than it is in the large conventional type. This, at first thought, would seem a paradox, and we should be grateful to them that they have brought it to our attention. They have shown us that one can get as much information from a small film as a larger film, and equally accurate, if not more so.

One must, of course, follow up a discussion such as theirs by emphasizing that at best the x-ray findings for the determination of cardiac enlargement are difficult to evaluate except in a negative sense. The borderline enlargements are very difficult to pick up in any type of examination. I believe the examination of the heart has its greatest value in determining the prognosis of the individual case.

I have naturally been most interested in the study reported by Drs. Wigh and Gilmore, since it was carried out in my own department. I think they have offered a very thorough review of the literature and the present problems involved. The most important thing for me to emphasize is

their demonstration of the reversal of the incidence of the so-called "malignant abscess" and the benign simple lung abscess. This is a very helpful observation to many of us who work in a general laboratory. It tells us that every hole in the lung in a patient above forty should be regarded as suspicious of possible malignancy regardless of sex.

It is always salutary to work out an analysis of one's diagnostic criteria periodically and as meticulously as possible, for in the general laboratory one is confronted with several possibilities when a cavity in the lung tissue is observed. Not all cavities are tuberculous or abscesses, and one must consider other lung lesions as possibilities, such as cysts, bullae, necrotic neoplasm, etc.

We should be grateful to the essayists for the time and effort they have taken to make this close analysis of the x-ray findings. I think you will all agree that they have done it in an excellent manner.

**Walter L. Stilson** (Los Angeles, Calif.): I congratulate Drs. Hanelin and Eyler on their excellent presentation of the findings in pulmonary artery stenosis. We had supposed, mistakenly, that pulmonary artery thrombosis or embolism was synonymous with infarction until we had a case showing findings similar to those presented here. The patient was a forty-three-year-old male who gave a history of a mild acute upper respiratory infection one year previously, from which he recovered. His presenting complaint was a pro-

gressive exertional dyspnea of four months duration, so that at the time he entered the hospital he could walk only twenty steps. Cyanosis was minimal on admission but became very severe, and was associated with oxygen hunger, when he died twenty-four hours later. The roentgenogram of the chest shows the findings described by Drs. Hanelin and Eyler. The right interlobar artery was markedly prominent, with an abrupt termination at the site of the pulmonary embolism demonstrated at autopsy. The lower right lung distal to this site was avascular and appeared more radiolucent. Oblique projections demonstrated definite prominence of the pulmonary conus and of the right ventricle, indicating the presence of cor pulmonale.

It seems to me that two points are worthy of emphasis: First, pulmonary artery occlusion does not necessarily result in infarction. Apparently previous cardiac embarrassment is necessary to produce infarction. Secondly, such pulmonary artery occlusion occurs in patients who are apparently well. The source of the obstruction in our case was the veins of the leg, since autopsy demonstrated thrombi in these vessels.

Those of you who were at Dr. Baker's class in venography will recall that he mentioned that venous thrombosis of the deep veins of the leg frequently occurs without any evidence clinically, or with minimal clinical evidence. Our patient had no symptoms referable to his legs, yet they were the source of the embolus which caused his death.



# Radium Therapy of Carcinoma of the Cervix Uteri

## A Method of Dosimetry Affording a Complete Description of Physical Factors<sup>1</sup>

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NO COMPLETELY descriptive system of radium dosimetry enjoys wide application in the intracavitary treatment of carcinoma of the cervix uteri. Expression of dosage in terms of so many "milligram hours" entails the use of a partial description without the specification of doses delivered to the cervix and other points of interest. Backed by sufficient clinical experience, the simple statement of "milligram hours" may permit a measure of reproducibility of results in the hands of certain individuals, but it is neither complete nor accurate enough to serve as the physical basis for the comparative evaluation of results obtained by all workers.

At the present time, the "gamma roentgen" offers the best means of dose description. Although it does not specify energy absorbed by tissues, its utilization as the basis of a scheme of dosimetry obviates the inadequacies of the "milligram hours" descriptive device.

A system utilizing the gamma roentgen as its basis is herein presented. We feel that we have had adequate clinical experience with its application to justify presentation in the literature. Sufficient time has not elapsed for five-year survival studies.

### BASIC CONSIDERATIONS

A scheme of dosimetry, although it may be technically perfect, is not practical unless it can be used by all busy radiologists and gynecologists. To gain general adoption, the system must be relatively simple; it must be based on sound physical principles; it must have had successful application, clinically and statistically.

The evolution of an adequate dose description requires consideration of the following points: (a) the designation of significant neoplastic areas and desirable dosages to be delivered; (b) the designation of limiting structures and ranges of dose tolerance; (c) a complete description of physical factors.

### CLINICAL AREAS

Guided by the work of Tod (1), Neary (2), Henriksen (3), and other authorities, we have designated the following pelvic points as indices of therapeutic efficiency. Their designations, locations, optimum dosages, and tolerance limits are subject to revision as dictated by the course of events. Experience may ultimately show other points to be of equal or perhaps greater significance.

#### *Neoplastic Areas: Designation and Dosage Levels*

"X" designates the *visible and palpable outermost limits of the carcinomatous cervix mass if separable from parametrial involvement*. This limit can be established in most League of Nations Stage I and II cases. It may be lost in the continuity of parametrial involvement when more extensive disease is present. The evaluation is made at the time of original staging.

We have established, as a working basis, a minimum of 7,000 and a maximum of 18,000 gamma r to point "X," when using a continuous, unfractionated course of radium therapy in three to five days. With fractiona-

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tion, the upper limit has been raised to 22,000 gamma r for two fractionations and 24,000 gamma r for three fractionations, when given in two and three weeks respectively.

"P" represents the *outermost limit of parametrial involvement as determined by pelvic examination*. We make every attempt to deliver a dose of *at least 4,000 r of x-rays and 2,000 gamma r to this point*.

"W" is the *point of greatest possible parametrial extension, i.e., the mid-point of the junction of the parametrium and pelvic wall*. Points "P" and "W," of course, become synonymous if carcinoma involves the pelvic wall. Point "W" may be anatomically located on the inner surface of the pelvic wall as the mid-point of a line drawn from the ischial spine to the point on the homolateral pelvic brim where the round ligament emerges.

The relationships between the variably situated cervix and radium applicator and the fixed point "W" are established radiographically by means of lateral and anteroposterior pelvic films. The lateral view affords cephalo-caudad relationships of the applicator to point "W," whereas the anteroposterior film establishes lateral distances (Fig. 2). On the lateral pelvic film, point "W" may be designated as a point on the acetabular rim at its most postero-caudad visible portion.

It should be stated that point "W" as indicated here is different from the point "B" utilized by Tod. Tod's point "B" is an arbitrary designation 5 cm. from the midline of the uterus and on the same level as her point "A." Point "W," on the other hand, is directly ascertained for each case by radiographic means and furnishes an index of the dosage level at the most lateral attachment of the broad ligament, which is usually more lateral by at least 1 cm.

than the obturator node (as indicated by Tod's point "B").

We try to deliver a dose of *at least 4,000 r of x-rays and 2,000 gamma r to point "W."*

"U" is the *intersection of ureter and uterine artery*. Todd (15), and Tod and Neary have established the paracervical triangle as being a most critical one in radium therapy of carcinoma of the cervix. Our point "U" represents the site of *intersection of the ureter and uterine artery within the paracervical triangle*. Henriksen has found a node or node group at this location (paracervical node) neoplastically involved in 31 per cent of 26 untreated and 47 per cent of 15 treated cases of cervical carcinoma. Since uremia is the cause of death in about 60 per cent of untreated and 50 per cent of treated cases, and since about 80 per cent of all treated cases have evidence of ureteral compression or kidney damage (3), we feel that the uterine artery-ureter intersection in the paracervical triangle is of great importance. It represents both a vital limiting structure (ureter) and neoplastic area (nodes), and therapy to this area must therefore be carefully evaluated and balanced.

As a result of urographic studies, anatomical review, and discussions with gynecological surgeons, we use, as a practical definition of the intersection of the ureter and uterine artery, a point *in the coronal plane 3.5 cm. lateral to the axis of the cervical canal (or tandem) at the level of the internal os*.

Normal variations, displacement by neoplastic infiltration in the area, or distortion due to fibrosis, will not, on the average, be more than 1 cm. in any direction from the defined point. With neoplastic involvement, it is our observation that the intersection tends to be displaced laterally.

It is to be emphasized that our point "U" differs anatomically from Tod's point "A" representing the paracervical triangle in general. Dr. Tod defined her point "A" as "2.0 cm. lateral to the central canal of the uterus and 2.0 cm. from the mucous membrane of the lateral fornix in the axis of the uterus." In our experience, the internal os level bears a more constant relationship to paracervical triangle structures than does the vaginal mucosa of the lateral fornix, which frequently is distorted by effacement by the time of planned radium insertion.

Compared to Tod's point "A," our more lateral disposition of point "U" effects lesser dosages delivered to the area in the individual case. This causes it to be relatively less crucial as a limiting factor, but conversely more of a problem in the treatment of this commonly involved node area.

Richards (4), quoting Tod, states that the paracervical triangle upper tolerance range is 7,500 to 8,500 gamma r with weekly fractionations over two to three weeks. For point "U," we are setting 6,000 gamma r as the upper limit when a single application is used, and 7,500 and 8,500 r with one and two fractionations respectively.

#### *Limiting Structures and Tolerance Ranges*

"V": *Lateral fornix.* This point will vary from patient to patient, but generally it will be close to the junction of the vaginal mucosa and the cervix. For radiographic localization, a metallic skin clip, applied in the lateral fornix at the time of radium insertion, has proved to be useful (Fig. 2A).

We have placed the upper limit of tolerance at point "V" as 18,000 gamma r when a single application is used, 22,000 gamma r when fractionated methods are employed over

a period of two weeks, and 24,000 gamma r with fractionation over three weeks.

"R": *Rectal point nearest the radium applicator.* This midline point can usually be determined on a lateral pelvic roentgenogram (with applicator in place) due to gas in the rectum. When the patient does not have rectal gas, we streak the anterior rectal wall with barium paste (Fig. 2B). In some cases the closest rectal point is cephalad to the fornices and therefore out of range of efficient vaginal packing.

Our upper limit of tolerance has been set as 4,500 gamma r for an unfractionated application and 5,000 gamma r with fractionations over two to three weeks.

"Bl": *Bladder point nearest the applicator.* Several methods may be employed to demonstrate this midline point. The simplest is to put air or 12 per cent sodium iodide into the bulb of the indwelling catheter to act as a contrast medium (Fig. 2B). These methods suffice if light traction is placed upon the catheter at the time of radiography, thus pulling the bulb to the region of the trigone. We allow 4 mm. for thickness of the bladder wall. For more exact visualization of the confines of the bladder, 12 per cent sodium iodide may be put into the urinary bladder at the time of radiography.

The upper limit of tolerance for the bladder point with an unfractionated application has been set at 5,000 gamma r. With weekly fractionations over three weeks, the limit is increased by 500 r for each week.

The most critical area may be different from patient to patient, and occasionally separate applications in the same individual will demonstrate different tissues to be the greater limiting factor.



## DESCRIPTION OF PHYSICAL FACTORS

Gamma roentgen dosages may be expressed arithmetically (authors' choice), or they may be designated by means of isodose curves. Some of the latter, photometrically produced, as that of Nolan and Natoli, mentioned by Ernst (5), diverge from calculated isodose curves to a degree that may be of clinical significance. In gen-

*The Dose Table:* The table is one of those published by Dr. E. H. Quimby, from which it is possible to obtain the number of gamma r not only at perpendicular distances away from the center of a linear source, but also on either side of this central plane (Fig. 1). It is apparent from the table that, at any particular radius from any particular point along the tube axis,

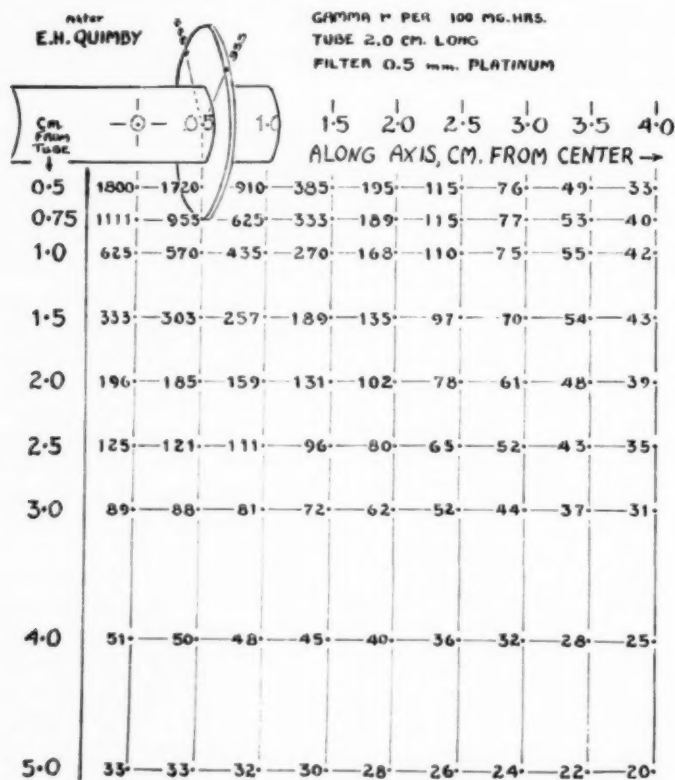


Fig. 1. Gamma r per 100 mg. hr. at various points from the axis of a tube of radium 2.0 cm. active length and an encasement filtration of 0.5 mm. of platinum. (After Dr. E. H. Quimby.)

eral, calculated isodose curves are more reliable than those photometrically constructed (6).

Fundamentally our dosimetry system consists of: (A) utilization of published tables affording dose quantity and distribution about a tubular radium source; (b) utilization of a mechanical applicator; (c) graphic localization of clinical and radium points.

all circumferential points will have identical values. Note that the example point is located by going 0.5 cm. from the center, along the axis, and 0.75 cm. away from the tube. Similarly any point in space can be located exactly with respect to the center of any linear or tubular radioactive source.

In an attempt to facilitate calculations and cover all possible contingencies we have, with Dr. Quimby's approval, modi-

fied her table (6) in the following points.

(1) *Extension of the Table to 10 cm. Perpendicularly from the Tube Axis:* This is done by inverse-square law, which manipulation does not effect significant error if applied to distances greater than the active length of the radioactive source (7).

(2) *Correction for Filtration:* Our radium is encased in 1.0 mm. platinum. The walls of our mechanical applicator have an average thickness of 2.3 mm. of brass. Therefore, our total filtration above the 0.5 mm. platinum utilized as a base by Dr. Quimby in her tables is 0.5 mm. platinum (14 per cent) plus 2.3 mm. brass (11 per cent), or a total of 25 per cent decrease in intensity.

(3) *Conversion from Gamma r per 100 mg. hr. to "Gamma r per mg. hr":* The figures are divided by 100.

A copy of our modified table is shown as a part of our clinical sheet (Fig. 4), but it must be emphasized that it can be used only with sources of 2.0 cm. active length and filtration factors identical with ours. Similar tables can be easily constructed for the specific conditions present in the various clinics.

*Utilization of a Mechanical Radium Applicator:* The ideal mechanical applicator should meet certain requirements:

(1) It should be adaptable to any situation that may arise relative to cervical carcinoma. This implies a choice of tandem active lengths as well as a wide choice in disposition of the colpostat-arranged sources. Both are necessary to effect adaptation to the variable conditions encountered.

(2) It should be simple to apply and remove. The applicator cannot be bulky. It must lend itself to complete immobilization. Excessive exposure to the operator must be avoidable.

(3) It should keep its mechanical accuracy. The relative positions of sources must not change, once they are chosen.

(4) It must permit a homogeneous dosage pattern around the cervix without excessive irradiation of the more sensitive

structures such as the rectovaginal septum.

(5) It must be easily cleaned.

Many satisfactory mechanical applicators for radium therapy of carcinoma of the cervix have been devised. At present we are using the Ernst type (5), but others such as that of Campbell (8) would probably serve as well. Our Ernst applicators have proved adaptable to almost any situation arising relative to cervix carcinoma.

*Graphic Localization of Clinical and Radium Points:* The centimeter graph can be called a planar "centimeter grid." By means of this grid, any point in the pelvis can be located exactly with reference to the center of each radioactive linear (tubular) source (Fig. 1).

In an attempt to achieve the greatest possible accuracy in measuring the distance of clinical points from the centers of the radium sources, we have used a system entailing calibration of the mechanical applicator as a check against purely radiographic methods. As a result of this cross-checking, we have concluded that either method may be used alone without significant error. Carefully used, the radiographic method alone will probably supplant the combined one due to its simplicity and accuracy within practical limits.

(1) *Calibration of the Ernst Applicator:* To calibrate the variables of the applicator we file reference lines on the stationary shaft and on the turnscrew. For each turn, the centers of the colpostat-arranged sources are plotted on centimeter graph paper by removing the caps from the containers and pressing the open ends of the containers on an ink pad.

A useful device is a stencil of cleared x-ray film upon which the positions of all the sources per turn are plotted from the master calibration described above. Small holes are punched for source centers. With a pencil pushed through the holes, it is a simple matter to plot the position of the source centers on the grid of the clinical sheet (Fig. 4), for the particular number and position of the tandem and colpostat-arranged sources used in a given case.

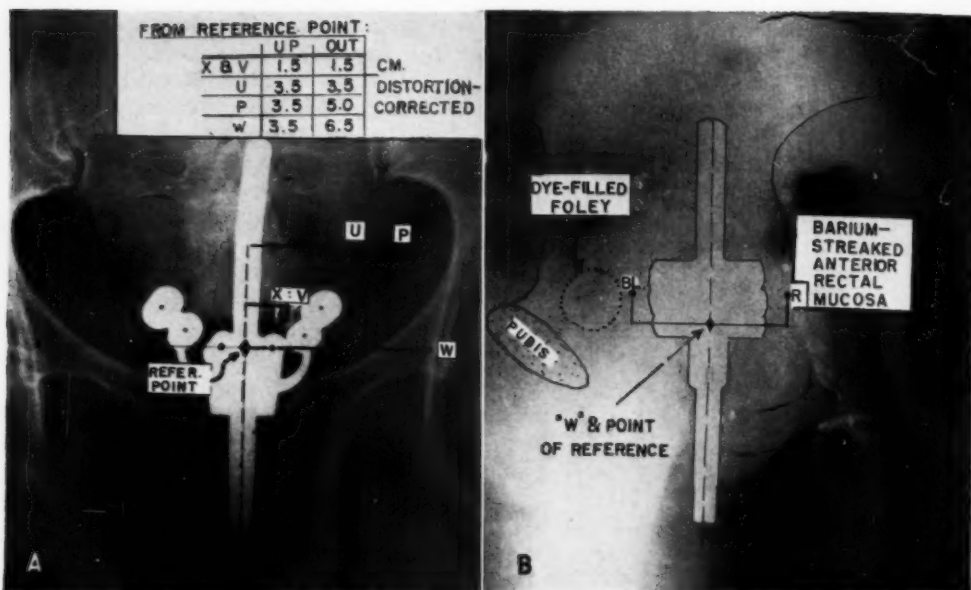


Fig. 2. A. Anteroposterior pelvic radiograph demonstrating the location of coronal plane clinical areas of interest with respect to the common point of reference.

B. Lateral radiograph demonstrating positions of bladder and rectal points relative to point of reference.

It has been our experience that the Ernst applicators differ mechanically from one another and must be individually calibrated. The wide-open position is most frequently used, but the other positions have been plotted in order to have the widest possible latitude in the adaptation of the applicator to the variable fornices encountered.

(2) *The Radiographic Method:* With the applicator in place, at 6-foot target-film distance, a lateral film of the pelvis is taken. From the lateral view, the manipulation of the tube and/or patient needed to get an end-on view of the colpostat sources is noted, and an anteroposterior pelvic film is obtained.

The location of the centers of the colpostat-arranged sources is easily seen on the anteroposterior view. The tandem source centers are established by prior direct examination and measurement of the unloaded applicator, the centers being related to some radiographically visible and constant point of reference on the applicator.

With the centers of all the sources established, they can be related to the clinically and radiographically located clinical points of interest.

(3) *Charting Clinical Points on the Grid:* The point-representations of neoplastic and limiting structures are determined from the anteroposterior and lateral pelvic films. These points are plotted on the planar centimeter-grids by relating them to a radiographically visible common point of reference on the applicator. We have chosen for this purpose the point midway between the centers of the two proximal colpostat-arranged sources (Fig. 2A). This point of common reference falls on the axis of the tandem sources as well as being in the plane of the centers of the colpostat-arranged sources. Any pelvic point of interest may be plotted on the centimeter-grid with respect to the point of reference.

We have found it expedient to put a skin clip on the distal-lateral aspect of the cervix at the time of applicator insertion. This clip permits the radiographic localization of the external os with relation to the

point of reference (Fig. 2A). It has been our experience that one cannot assume that the external os will stay flush with the applicator cross-bar. The range of separation of the external os and the point of reference has been from 1 cm. (irreducible minimum) to 3.5 cm. These relatively small distances cause large dosage variations. We feel this simple maneuver to be very important. (In general, when utilizing the gamma r method of dosimetry, dis-

will become apparent when the example of dosimetry is followed.

Point "U" is plotted on the anteroposterior grid. It is located, as a representation of the ureter-uterine artery crossover, by placing it 3.5 cm. lateral to the tandem axis at the level of the internal os. Whenever possible, the distance of the internal os from the external os is measured by a sound at the time of applicator insertion. A skin clip on the distal-lateral lip

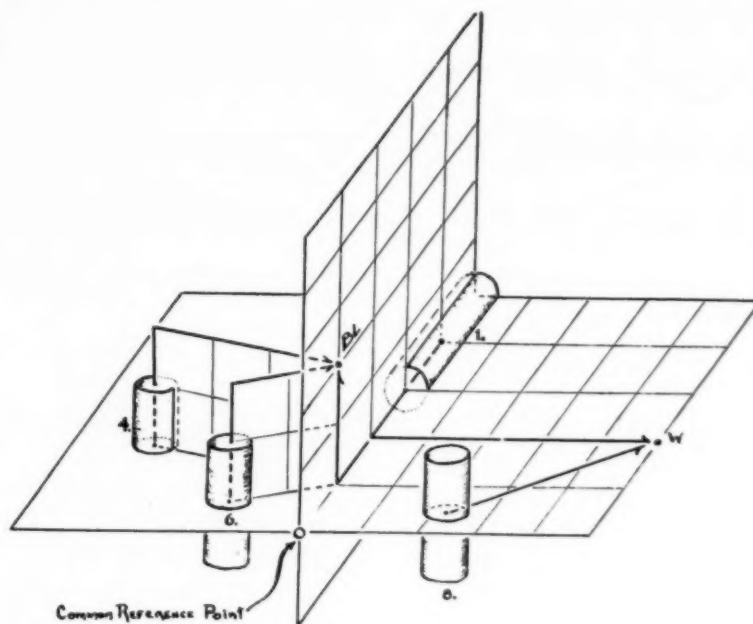


Fig. 3. Isometric presentation of representative radium sources with respect to illustrative pelvic points.

tances must be determined as precisely as practicable.)

In the anteroposterior view the centers of all the sources are in the same plane with points "X," "V," "P," "U," and "W." These clinical points can be easily plotted on the anteroposterior portion (alone) of the centimeter-grid (Fig. 2A; 4, AP).

Since they are midline in the anteroposterior view, points "BL" and "R" are plotted on the "lateral" portion of the grid first, then located on the anteroposterior view as well (Fig. 2B; 4, Lateral, then AP). The necessity of this latter step

of the cervix radiographically identifies the location of the external os. The internal os is usually from 2 to 3 cm. from the external os.

#### DETERMINATION OF DOSAGES TO CLINICAL POINTS

When all clinical areas are located on the grid, their exact positions relative to the axis and to the center of each linear (tubular) radium source are established. In Figure 3, for example, "W" is 2.0 cm. along the axis and 5.0 cm. lateral to the representative tandem source 1. From the col-

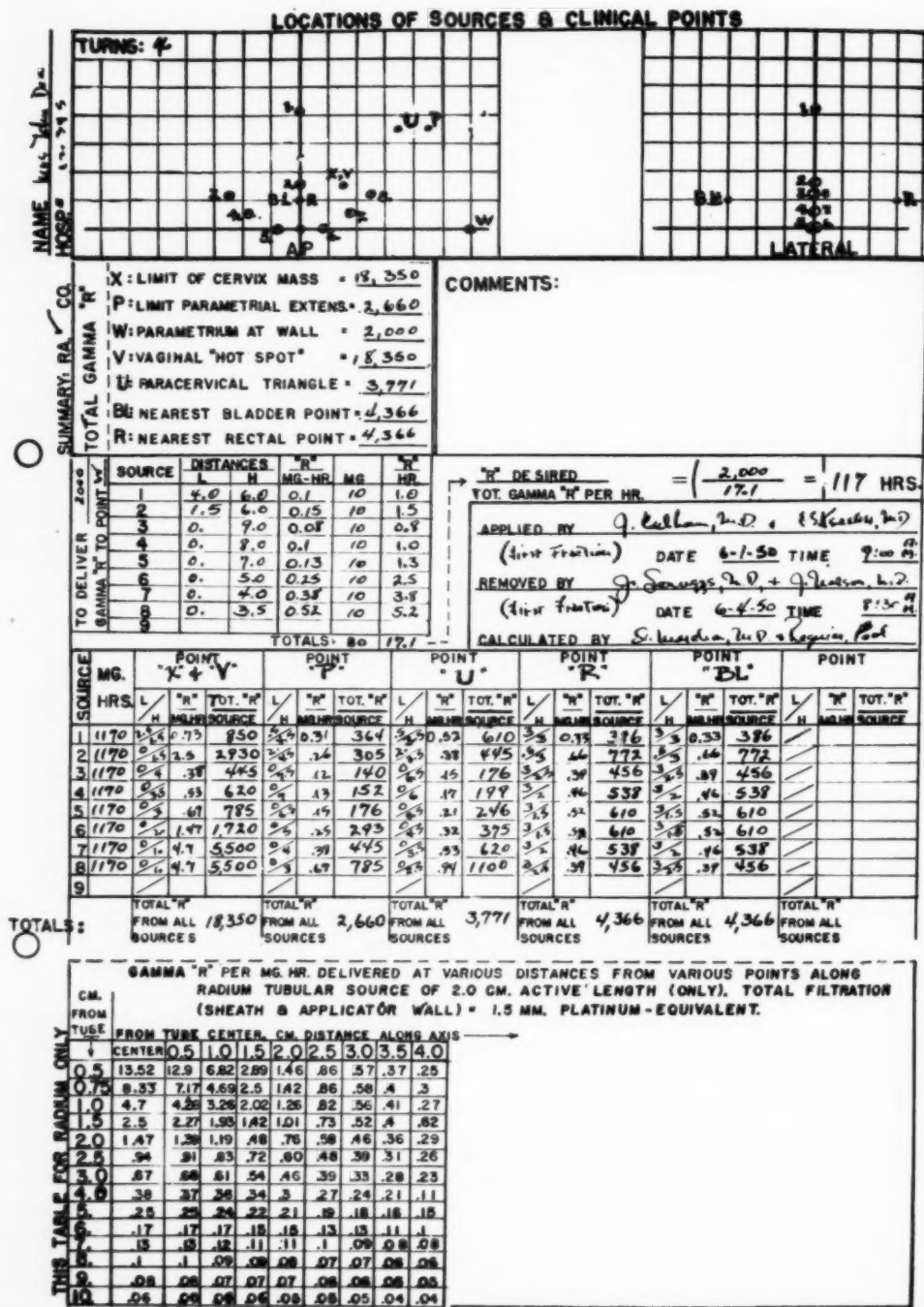


Fig. 4. Clinical sheet employed for individualized full physical description of the therapeutic application of radioactive sources. The various sections afford convenient tabulation and calculation of doses.

The centimeter grid at the top permits a permanent and accurate record of the relative positions of the radioactive sources and pelvic points of importance.

(Legend continued at foot of opposite page)



postat-arranged source 8, "W" is 0 cm. along the axis and the directly measured (with a cm. ruler) distance of 4.0 cm. Consequently the dose in gamma r delivered to point "W" from each source can be obtained from an appropriate table. Using Dr. Quimby's original table (Fig. 1), the dose delivered to point "W" from source 1 is 28 gamma r per 100 mg. hr. From source 8, "W" gets 51 gamma r per 100 mg. hr. The contribution to point "W" from each source is summated.

To a point in the sagittal plane such as the bladder point ("Bl") the contribution by each source is determined, then summated. From Figure 3 it is apparent that each colpostat-arranged source—4, 6, 8—has its individual plane referable to either the rectal or bladder points.

#### Example Case

**Clinical Status:** Let us say we have a patient with a Stage II (League of Nations) proved case of carcinoma of the cervix, who on admission had a large cervical exophytic mass and bilateral parametrial nodular extension out to 1.5 cm. from each pelvic wall.

In six weeks of externally applied x-ray therapy 4,200 x-ray r are delivered to points "W" bilaterally. At the post-x-ray therapy recheck, the cervix appears apparently normal with no nodular masses or exophytic growth. The parametria bilaterally are thickened, but no nodulations or masses are felt. There is a moderate effacement of the fornices.

Cystoscopy, proctoscopy, and a recheck intravenous pyelogram are all negative.

**Decision Regarding Radium Therapy:** To try to deliver about 2,000 gamma r to point "W."

**Surgical Procedure:** During dilatation of the canal, the distance of the internal from the external os is found to be 2.0 cm. Skin clips are clamped on both the distal-lateral cervical lip and on the vaginal mucosa of the partially effaced lateral fornix. The Ernst applicator is then inserted, and it is found that the patient's fornices will accommodate the wide-open (4-turns) position of the sources. The uterine canal can take only two tandem-arranged sources. Each radium source is 10 mg. The sources have the active length and filtration enabling the use of our table, shown at the bottom of Figure 4.

Air or urographic sodium iodide is put into the Foley catheter bulb.

The vagina is packed well away from the applicator, and a pressure pad taped into place over the projecting handle.

**Radiographic Localization:** The following day, in the Department of Radiology, the anterior rectal mucosa is streaked longitudinally with barium paste. At 6-foot target-film distance a lateral pelvic film is taken, centering on the applicator. From it the angulation needed to get end-on views of the colpostat-arranged sources is noted, and an anteroposterior pelvic film is taken. As determined from the films (Fig. 2A and B) and physical findings, the various radium and clinical points are transferred to the centimeter grid on the clinical sheet (Fig. 4).

First, one plots the positions, in both the anteroposterior and lateral views, of the centers of all of the sources by either the radiographic or calibration method, or both. The sources are numbered (Fig. 4).

**Relating Clinical Areas to the Point of Reference from X-Ray Studies (Fig. 2) to the Grid (Clinical Sheet, Fig. 4):**

"X" and "V": These points are synonymous in this instance due to obliteration of the fornices. From Figure 2A, both are seen to be located 1.5 cm. up from and 1.5 cm. lateral to the point of reference. The location is indicated on the anteroposterior portion of the cm. grid. Note that the clip shows the external os to be riding up on the tandem, 1.5 cm. from the point of reference.

"P": This is determined by palpation, 3.5 cm. up and 4.5 cm. out. The point is transferred to the anteroposterior portion of the centimeter grid.

"W": On the lateral pelvic film, point "W" may be identified as a point on the acetabular rim near its most postero-caudad visible portion. In this case (Fig. 2B), point "W" happens to be projected over the applicator common point of reference. Therefore, there is no cephalad or caudad displacement.

From the anteroposterior view (Fig. 2A), point "W" is measured as 6.0 cm. from the reference point. These relationships are plotted on the anteroposterior grid.

"U": The uterine artery (internal os) level, determined by sound at the time of radium application, is 2.0 cm. from the external os (or 3.5 cm. from the point of reference), thence 3.5 cm. laterally. This is plotted on the anteroposterior grid.

"R": The point of greatest rectal dosage has proved to be that nearest the center of the arc formed by the colpostat-arranged sources. From the lateral film of the pelvis, point "R" is seen to be 3.0 cm. posterior and 1.0 cm. cephalad from the point of reference and is so plotted on the "lateral" centimeter grid. In the anteroposterior grid view it

The second horizontal column is a convenient summary of doses delivered to designated points.

The third horizontal column permits the tabulation and determination of the total roentgens per hour, as well as the total hours necessary for the delivery of any desired dosage to any predetermined point of greatest interest.

The fourth horizontal column permits the tabulation and determination of the total dosages to other pelvic points of clinical interest in terms of the value obtained in the third horizontal column.

At the bottom of the clinical sheet is the Quimby table modified for use with our radioactive sources.

is projected in the midline, 1.0 cm. up from the reference point.

"Bl": The bladder point is 3.0 cm. anterior to and 1.0 cm. cephalad from the point of reference on the lateral view; in the anteroposterior view, it is in the midline, 1.0 cm. cephalad to the reference point. It is plotted on both portions of the grid.

*Determination of Dosages to Clinical Points:* We are trying to deliver 2,000 gamma r to point "W," from 15,000 to 18,000 gamma r to "X" (and "V"), and about 2,000 gamma r to "P," and still stay within the tolerance limits of 7,000 gamma r to point "U," 4,500 gamma r to "R," and 5,000 gamma r to "Bl." Our tentative plan is to use a single unfractionated application.

On the clinical sheet (Fig. 4), we use the section "To Deliver (2,000) gamma r to Point (W)."

Our sources are 10 mg. each. We enter the milligrams for each source in the appropriate column. To find the gamma r contribution from source 1 to point "W" (4.0 cm. along the axis and 6.0 cm. away from the tube) we find the appropriate figure in the modified Quimby table on the clinic sheet. It proves to be 0.1 gamma r per mg. hr. Multiplying by 10 mg. results in 1.0 gamma r in one hour.

Source 2 to "W": "L" (distance along the axis) is 1.5 cm., and "H" (distance from the tube) is 6.0 cm. Therefore, from the table, we have 0.15 gamma r per mg. hr., which multiplied by 10 mg. equals 1.5 gamma r in one hour.

Source 3 (colpostat-arranged): "L" equals 0 (if not obvious, see Fig. 3). "H" (measured with cm. ruler) equals 9.0 cm. According to this table, therefore, this source delivers 0.08 r per mg. hr., and this multiplied by 10 mg. equals 0.8 r per hour. The doses from the remainder of the colpostat sources are calculated in the same manner.

The contribution from all sources is summated, showing that point "W" gets a total of 17.1 gamma r from the combined sources in one hour. The desired dose of 2,000 gamma r divided by 17.1 gamma r per hour equals 117 hours.

The other columns on the clinical sheet are used to find the dosages to the other clinical points of interest in terms of 117 hours  $\times$  number of milligrams available. The points in the same coronal plane as "W" are similarly calculated. Points "X" and "V" being synonymous, this area will receive 18,350 gamma r. Point "P" will have 2,660 gamma r delivered to it.

Thus, source 1 (0.5 and 3.5) delivers (interpolation is permissible) 0.52 r gamma per mg. hr. times 1,170 mg. hrs., or a total of 610 gamma r to point "U" in 117 hours.

The summation of contributions from all sources is 3,771 gamma r.

Point "R": In calculating the dosage to rectal or bladder points from tandem sources, one simply uses the "lateral" portion of the grid. For example, point "R" is 3.0 and 3.0 cm. from source 1. Therefore, from the table, 0.33 gamma r per mg. hr. is delivered

which, multiplied by the number of mg. hr. (1,170), gives 386 gamma r delivered to point "R" from source 1. The dose from source 2 is similarly calculated.

Each of the colpostat sources has an individual plane referable to either "R" or "Bl" (see Fig. 3). In determining the contributions to "R" from source 3, the "Distance Along the Axis" (L) represents the 3.0 cm. that "R" is posterior to the tandem sources (as seen on the lateral grid).

To find "H" (cm. from the tube), one refers to the projection of "R" on the anteroposterior grid and measures the distance manually with a centimeter ruler. Thus "H" for source 3 to "R" is 2.5 cm. From the table this is 0.39 gamma r per mg. hr., which  $\times$  1,170 equals 456 gamma r. The doses from other colpostat sources are similarly calculated and the summation comes to 4,366 gamma r in 117 hours from all sources.

Point "Bl": Calculating in the same manner as for "R," we find a total of 4,366 gamma r delivered to the nearest bladder point.

*Case Discussion:* Our upper limits of tolerance may be conservative; but, based on these limits, 18,350 r to "X" (and "V") given at one sitting would perhaps be too much. A fractionation (one-half at the first sitting, a week rest, then the remainder) would allow the 18,350 gamma r to be given. This dosage should take care of the primary lesion; it contributes significantly to the areas of neoplastic extension (2,660 to "P" and 2,000 r to "W"), and yet remains within bounds of tolerance of limiting structures.

One could simply decrease the dosage to be delivered to points "X" and "V" to 18,000 gamma r for a single application. Naturally, the amount of time needed would be decreased, and the other points would get correspondingly lesser dosages.

## DISCUSSION

Because of our attempt to be explicit in written explanation, one may, on casual reading, get the impression that the system is complex or difficult. Such is not the case. The calculation of dosages is not a time-consuming operation. Only simple arithmetic is employed. In the process, however, a measure of insight into the physical aspects of dosimetry is obtained. It has proved to be enlightening to those workers who have not had an opportunity to acquire a thorough understanding of the factors comprising a complete dosimetry.

With this scheme of dosimetry one can pre-calculate, post-calculate, use any desired number of fractionations, and keep the treatment schedule as rigid or flexible

as one wishes. One can modify any of the factors and still know where one stands in relation to the whole treatment scheme.

A complete physical description of the radium treatment, including calculations, may be incorporated in a single sheet placed in the patient's chart. The table is at the bottom, and may be torn off if so desired.

The system is not perfect, but we feel that it is closer to a complete description than most dosimetries in use today. At some clinical points there is a decrease in intensity due to filtration by intervening sources, but this decrease is somewhat balanced by electron scatter. On the average the decrease will be less than 15-20 per cent.

Once the fundamental physical considerations are worked out, appropriate radioactive materials other than radium may be used. (One of our applicators and an appropriate dose-grid is being adapted for cobalt<sup>60</sup>. The information derived will be presented in a subsequent paper).

#### SUMMARY AND CONCLUSIONS

A method of dosimetry for radium therapy of carcinoma of the cervix uteri is presented. It is believed that this method offers a firm basis upon which to plan, evaluate, and compare clinical results. The system is widely applicable, is accurate, and yet is relatively simple to use.

The neoplastic areas used as indices of clinical results, and at which points dosages are calculated, are: (1) the outermost limits of the cervical mass; (2) the outermost limits of parametrial extension; (3) the mid-point of the junction of parametrium and pelvic wall.

The limiting structures used as indices are: (1) the rectum; (2) lateral fornix; (3) the bladder; (4) the intersection of the ureter and uterine artery.

The ureter-uterine artery intersection bears special reference as both a neoplastic area and a limiting structure.

All of the above points are specifically defined. The dose ranges presented for

each area are based on the published observations of other workers.

Fundamentally the dose scheme is based on the gamma roentgen and consists of: (1) an adaptation of published tables affording dose quantity and distribution about a linear (tubular) radium source; (2) a simple graphic means of locating any pelvic point with respect to the radium applicator and its individual sources; (3) the use of a suitable mechanical applicator.

A radium dosage sheet for the patient's chart is presented. It contains all the data necessary for a complete description of the physical factors involved in the individual case.

*Acknowledgments:* We are grateful to Dr. Edith H. Quimby not only for passing judgment on the soundness of the physical principles involved in the presented scheme of dosimetry, but also for checking the modifications of her table.

We express our great appreciation, also, for the constructive comments and aid offered by Dr. Willis Brown and Staff of the Department of Gynecology, and Drs. Calhoun, Pool, Scruggs, Regnier, Nelson, and Burnside of the Department of Radiology, as well as for the technical assistance given by Mr. Earl W. Pearson, Jr.

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#### SUMARIO

#### Curieterapia del Carcinoma del Cuello Uterino. Presentación de un Método Dosimétrico que Ofrece una Descripción Completa de los Factores Físicos

Al presentar un método de dosimetría para la curieterapia del carcinoma del cuello uterino, indicase que el mismo parece ofrecer una firme base para el planeamiento, justipreciación y comparación de los resultados clínicos. El sistema tiene amplia aplicación, y es exacto a la vez que relativamente sencillo en su empleo.

Las zonas neoplásicas tomadas como índices de los resultados clínicos y en las que se calculan las dosis son: (1) los límites más exteriores de la tumefacción cervical; (2) los límites más exteriores de la difusión paramétrica; (3) el punto medio de la unión del parametrio y la pared pelviana. Los órganos limitantes tomados como índices son: (1) el recto, (2) el fómix lateral, (3) la vejiga, (4) la intersección del uréter y la arteria uterina.

Todos los puntos anteriores se definen específicamente. Las escalas dosimétricas presentadas para cada zona se basan en las observaciones publicadas por otros técnicos.

Fundamentalmente, el esquema posológico está basado en el roentgen gamma, consistiendo en: (1) una adaptación de tablas publicadas que facilitan el tamaño de la dosis y la distribución alrededor de un foco lineal (tubular) de radio, (2) un sencillo medio gráfico de localizar cualquier punto pelviano en relación con el aplicador de radio y sus distintos focos, (3) el empleo de un aplicador mecánico adecuado.

Preséntase una hoja de dosis de radio para la gráfica del enfermo, que contiene todos los datos necesarios para una descripción completa de los factores físicos comprendidos en el caso dado.





# Calcification in Adrenal Neoplasms

## Report of a Case<sup>1</sup>

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NEOPLASMS OF the adrenal gland are not common, and extensive calcification in such tumors is unusual. The following case is of interest because of the prominence of the calcification, the size of the tumor, and the fact that the combination of roentgen, clinical, and laboratory observations permitted an exact histologic diagnosis antemortem.

A useful classification of adrenal neoplasms has been presented by Cahill (1, 2): (1) the rare neoplasms arising from various layers of connective tissue, including fibroma, neuroma, sarcoma, lipoma, etc.; (2) neoplasms arising from the medulla, including (a) sympathicoblastomas, also called neuroblastoma and neurocytoma (non-hormonal and malignant), (b) ganglioneuromas, and (c) pheochromocytomas (hormone-producing; cause of paroxysmal or sustained hypertension); (3) neoplasms arising from the cortex, namely (a) adenomas and (b) carcinomas. The cortical tumors may or may not produce hormones; if over-production of hormone occurs, it may be of either estrogen or androgen.

It is impossible to determine the true incidence of calcification in adrenal neoplasms, inasmuch as many case reports make no mention of its presence or absence. A brief review of the recent literature reveals no reference to calcification in benign neoplasms with two possible exceptions (3, 4). Several instances of calcification in malignant tumors—either sympathicoblastomas or carcinomas—are reported (5-10).

### CASE REPORT

A 40-year-old multipara gave a history of repeated attacks of chorea during her childhood. Until the age of thirty, she was not aware of any cardiac disability. At that time her physician made a diagnosis



Fig. 1. Chest film showing multiple metastases.

of "mitral insufficiency, slight mitral stenosis, and aortic insufficiency." The heart was said to be "top normal" in size and the left auricle was disproportionately large. The blood pressure was 126/60. The patient was asymptomatic.

In 1944, at the age of thirty-six years, the patient began to suffer from headaches and vertigo, associated with "puffiness" under the eyes. In 1946 she was told that she had nephritis. Her blood pressure was elevated and she had a retinal hemorrhage. In December 1946, congestive heart failure developed, and from that time until her death, in October 1948, the patient was confined to bed. Menstruation ceased abruptly in 1947, hirsutism developed, the features assumed a masculine appearance, there was increasing protuberance of the abdomen, with right upper quadrant and right flank tenderness, and the ageing process appeared to be greatly accelerated.

Coincident with these symptoms, a glaucoma of the right eye developed, leading to complete blindness. The patient was treated for the cardiac condition by her physician, receiving digitalis, mercurial diuretics, and a low sodium diet. When first seen by one of us (W. N. S.), in August 1948, she was in severe congestive heart failure with dyspnea, cyanosis, and anasarca. She presented diffuse pigmentation resembling extreme suntan, and her face was moderately bearded. Her skin was dry and coarse and the right eye was blind and moderately exophthalmic, with slight external divergence. The heart was enlarged to the left, but the rhythm was regular with a few ectopic beats. Loud apical systolic and variable diastolic murmurs were heard,

<sup>1</sup> Accepted for publication in September 1950.





Fig. 2. Excretory urogram showing downward displacement of kidney (K) by adrenal tumor (A) containing extensive granular calcification, which is difficult to delineate on the reproduction. The liver (L) cannot be separated from adrenal neoplasm.

but no aortic murmurs were detected. Coarse and bubbling râles were audible throughout both lungs. The abdomen was protuberant, but there was no definite evidence of free fluid. A mass was palpable in the right hypochondrium and the liver edge descended 10 cm. below the costal margin and was nodular and tender. Blood pressure varied between 180/120 and 240/130. The clitoris was not enlarged. Fluoroscopy revealed multiple round masses in both lungs and marked cardiac enlargement involving both ventricles and the left auricle.

The only significant laboratory finding was an elevation of the 17-ketosteroids in the urine to 24.3 mg. in twenty-four hours (normal for the adult female, 6 to 13 mg.).

Roentgen examination of the chest (Fig. 1) revealed multiple round, sharply circumscribed parenchymal densities, typical of "cannon-ball" metastases of a malignant neoplasm. The fluoroscopic demonstration of cardiac enlargement was confirmed. On excretory urography, both kidneys were found to concentrate poorly. The right kidney was deformed and displaced (Figs. 2 and 3) downward and laterally by a large supra-adjacent mass containing scattered granular, calcific material. The superior aspect of the mass could not be distinctly outlined. The differentiation between cortical carcinoma and sympathicoblastoma could not be made on the basis of the x-ray examination alone.

The patient died one year and ten months after the abrupt onset of the clinical picture of congestive heart failure, hirsutism, pigmentation, etc., and four

years after she was first told that her blood pressure was elevated.

*Autopsy Report:* Grossly there was revealed a large cortical adenocarcinoma replacing the right adrenal (Fig. 4), measuring approximately  $25 \times 15 \times 5$  cm. The mass was tightly adherent to the liver, with direct extension of large yellow-gray nodules into the right lobe. Section of the tumor revealed diffuse areas of calcification and necrosis throughout.



Fig. 3. Excretory urogram, right posterior oblique view, showing kidney (K) and adrenal carcinoma (A) with extensive, finely granular calcification, better shown on the original.

Multiple rounded nodules were present in the liver and lungs. No involvement of the brain, orbits, skull, right kidney, or other organs was noted. The heart was markedly enlarged, showing old mitral valvulitis with rounding and thickening of the free margins of the leaflets. The left ventricle measured 23 mm. in thickness and the right ventricle 10 mm.

Microscopically the right adrenal showed complete loss of normal structure, which was replaced by large lobules of neoplasm, separated by thick connective tissue septa. Many lobules showed complete necrosis. Others were composed of sheets of large foam-like cells with central rounded or shrunken nuclei. Few mitotic figures were noted. Fat stains showed the tumor cells to be filled with small and medium-sized fat globules in areas of

partial necrosis. The viable tumor cells contained almost no stainable fat. The left adrenal was normal, as were the kidneys. The tumor nodules in the liver and lungs histologically resembled cells of the adrenal cortex. Zenker's stain showed no chromaffin substance.

The clinical diagnosis, supported by the autopsy, was: (1) right adrenal cortical adenocarcinoma with liver and lung metastases; secondary masculinization; (2) hypertension and hypertensive cardiovascular disease; (3) cardiac enlargement and congestive heart failure; (4) rheumatic heart disease with mitral stenosis and insufficiency; (5) right amblyopia secondary to glaucoma.

#### DISCUSSION

Although the true incidence of calcification in neoplasms of the adrenal gland is impossible to determine from the cases reported in the past, it is evident that it is more frequently seen in the malignant tumors, either sympathicoblastomas or carcinomas. There is no evidence that the deposition of calcium salts is due to any peculiar function of the adrenal cells, but rather it is the calcification that is seen in any large necrotic mass of tissue; the "dystrophic calcification" of Widmann *et al.* (10).

Of all neoplasms which show calcification, carcinomas are among the least common according to Bignami and Ferretti (11), being surpassed by chondromas, cystic tumors, gliomas, vascular tumors, and sarcomas, in that order. The calcification in the present case was helpful in establishing the diagnosis. However, such an appearance must be differentiated from other types of calcification in the upper quadrants of the abdomen, as calcified mesenteric lymph nodes, pancreatic calcifications, renal calcifications, and calcification in costal cartilages.

Of interest in the present case was the fact that a specific histological diagnosis could be made antemortem. The initial finding of pulmonary metastases established the process as a malignant neoplasm. The presence of a mass above and displacing the kidney located it presumptively in the adrenal. The extensive calcification indicated either a sympathicoblastoma or carcinoma. The clinical virilism and elevation of the 17-ketosteroids in the urine

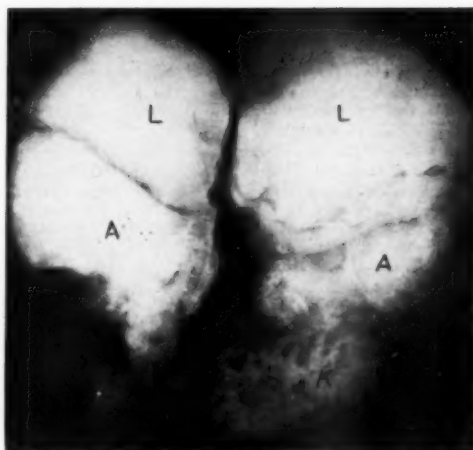


Fig. 4. Roentgenogram of bisected autopsy specimen. The kidney (K), adrenal adenocarcinoma (A), and liver (L) were removed *en bloc*. Calcification throughout the tumor is shown.

ruled out a sympathicoblastoma. Only a cortical carcinoma could account for the combination of findings. Of further clinical interest was the rather complex past history of rheumatic heart disease, alleged chronic nephritis, and glaucoma.

The neoplasm in the present case is believed to be among the larger adrenal carcinomas reported. Because of its direct extension into the liver, exact weight determinations could not be made. From the dimensions, however, a weight of approximately 1,500 gm. can be estimated. No mention of the weight of adrenal carcinomas recorded in the literature was found.

#### SUMMARY

A case of adrenal neoplasm of unusual size with prominent calcification is reported. Complicating conditions were rheumatic heart disease, hypertension, and glaucoma.

Since calcification is unusual in adrenal tumors except carcinomas and sympathicoblastomas, it may be an important differential aid. In the case recorded here the combination of clinical, laboratory, and roentgen findings permitted an exact histologic diagnosis antemortem. This was confirmed at autopsy.

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## SUMARIO

## Calcificación en las Neoplasias Suprarrenales. Presentación de un Caso

El caso comunicado de adenocarcinoma corticosuprarrenal resulta extraño por virtud de la presencia de extensa calcificación. El tumor era también notable por su tamaño: 25 × 15 × 5 cm. Suplantaba la suprarrenal derecha, se extendía hasta el hígado y había además metastatizado en los pulmones. La calcificación, observable roentgenológicamente, resultó útil para establecer el diagnóstico, indicando ya simpaticoblastoma o carcinoma, por

ser más frecuente en las neoplasias adrenales de esas formas. Clínicamente, el virilismo y la elevación de 17-quetoesteroides en la orina excluyeron el simpaticoblastoma. El diagnóstico de adenocarcinoma fué confirmado en la autopsia. Factores complicantes fueron cardiopatía reumática, hipertensión, y glaucoma.

En las neoplasias suprarrenales, una calcificación extensa puede constituir un auxiliar en el diagnóstico diferencial.



# Pantopaque Pulmonary Embolism During Myelography<sup>1</sup>

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**I**ODIZED OILS injected into the subarachnoid space to demonstrate lesions in the spinal canal have been used with increasing frequency since Sicard and Forestier (1) published their observations on lipiodol myelography in 1922. Pantopaque (ethyl iodophenylundecylate) has largely replaced lipiodol since its introduction in 1944 by Ramsey, French, and Strain (2), because it is less viscous and has been thought to be less irritating and more readily absorbed. Subsequent experience has shown, however, that very little of the medium is absorbed from the spinal canal, and collections of it have been found over long periods following its injection into the subarachnoid space (3, 4). Because of its irritating effects upon the meninges, it has been necessary to remove the pantopaque after examination has been completed.

Pantopaque myelography when properly done has proved to be a relatively harmless and useful procedure. However, two cases of venous intravasation of the oil have been reported (5, 6). To these we add a third case, with roentgen demonstration of the opaque substance in both lungs.

## CASE REPORT

T. D., a 28-year-old white female, was admitted to the University of California Hospital on July 12, 1948, complaining of pain in the right popliteal region of six weeks duration. The pain radiated superiorly as far as the gluteal fold and inferiorly to the Achilles tendon. The only abnormal physical findings were tenderness to palpation over the spines of the first three lumbar vertebrae; hypesthesia over the lateral aspect of the right lower extremity; impaired leg raising on the right side, and slight extension to the left on flexion of the trunk.

Roentgen examination of the chest (Fig. 1), lumbosacral spine, and right knee revealed no evidence of disease. The blood count showed 12.9 gm. hemoglobin, 4,500,000 red cells, and 8,000 white cells, with a normal differential count. The urine was normal.

A spinal puncture was performed. The pressure was greater than 50 mm. of water with the patient in a horizontal position. With straining and jugular compression, there was free movement of the fluid column. The cerebrospinal fluid examination showed 6,000 fresh red blood cells per cubic millimeter, Pandy 0, protein 43 mg. per cent, serology negative, colloidal gold, 0.0000000011.

At 3 P.M. on July 13, 9 c.c. of pantopaque were injected into the subarachnoid space. The pantopaque column was followed fluoroscopically from the level of the first lumbar vertebra to the caudal sac, and spot films were taken. No unusual contours or filling defects were noted. On attempted removal of the oil, gross blood returned freely. The needle was removed and another (No. 19) inserted in the interspace between the fourth and fifth lumbar vertebrae. One and one-half cubic centimeters of pantopaque were removed, together with a small amount of bloody fluid. The spinal canal was again observed fluoroscopically and opaque oil was visible. The patient then complained of a slight chest "pressure." At 10 P.M., she had a slight non-productive cough and complained of chest pain. Physical examination of the chest was negative.

The next day the patient was sent to the X-ray Department, at which time she suddenly felt "tired all over," began to perspire profusely, became nauseated, vomited repeatedly, and complained of a ringing sensation in her ears. The roentgen examination was postponed, and on the following day chest films revealed in both lungs multiple small, fine, reticular densities which appeared to lie chiefly anteriorly (Fig. 2). The temperature went up to 37.5° C. on July 14, and to 38.25° C. on July 15. In view of the possibility of pulmonary complications, papaverine, nicotinic acid, and demerol were given. The temperature gradually fell and was normal on July 17. The total white blood count on that day was 8,600 cells per cubic millimeter, and the anterior chest pain, which was very severe on

<sup>1</sup> From the Department of Radiology, University of California School of Medicine, San Francisco (H. L. S.), and the Department of Radiology, Huntington Memorial Hospital, Pasadena, Calif. (W. B. H.). Accepted for publication in September 1950.

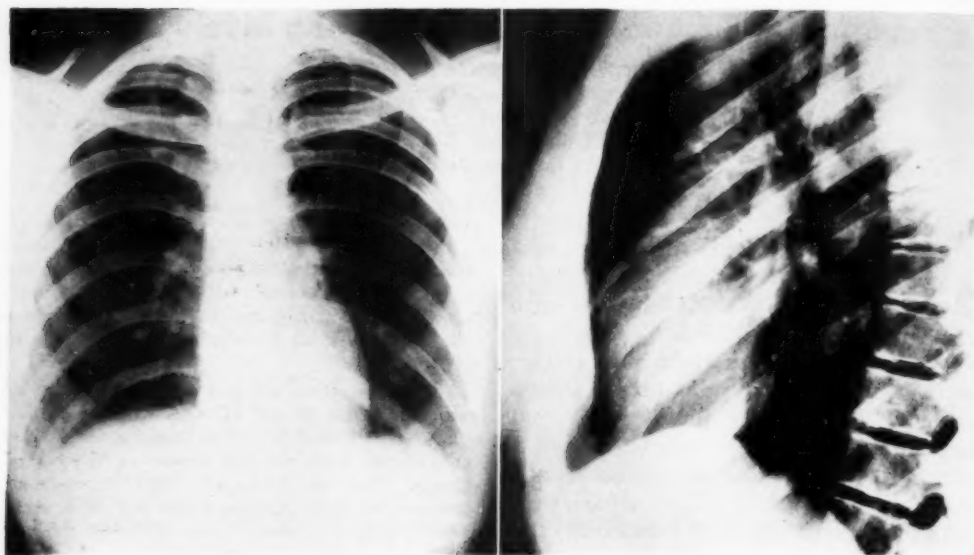


Fig. 1. Roentgenograms obtained July 13, 1948, showing a normal chest.

July 15 and July 16, had subsided. On July 19 an x-ray examination showed the multiple small, discrete densities in both lungs still present and apparently unchanged. Repeated physical examinations of the chest were negative.

The patient was discharged from the hospital with the diagnosis of (1) right popliteal pain of undetermined etiology, (2) psychoneurosis, and (3) pantopaque pulmonary emboli. On June 7, 1950, roentgenograms of the chest (Fig. 3) revealed no evidence of the pantopaque emboli or other significant disease, though the patient still complained of slight chest pain.

#### DISCUSSION

Intravasation of the venous system during myelography has been reported by Hinkel (5) and Fullenlove (6), but the fate of the pantopaque emboli was not observed roentgenologically. Hinkel found that 56.65 mg. of the iodine was excreted in the urine in the first twenty-four hours. A roentgenogram of the chest failed to reveal any evidence of the opaque oil or pulmonary infarction. Fullenlove does not state the amount of pantopaque used, and no chest film was made in his case, although the chest was observed fluoroscopically and appeared to be normal.

Ingersoll and Robbins (7) reported a case of oil embolism of the lungs follow-

ing hysterosalpingography. Examination showed lipiodol within the blood vessels of the lung one day after the hysterosalpingography was performed. The patient experienced pain in both sides of the chest. Films obtained seven days later revealed numerous patchy shadows of increased density in both lungs, which were interpreted as pulmonary infarcts. No definite shadows due to the lipiodol were seen at this time. The patient's temperature was elevated for four days.

Gunn, in Anderson's *Pathology* (8), states that "fat embolism is not a cause of infarction of the lung because of the small size of the globules which are filtered out in pulmonary capillaries and arterioles. Patchy hyperemia and edema constitute the only changes recognizable in the lung itself except the stuffing of numerous small blood vessels with oil or fat. When death occurs in fat embolism, it is the result of embolization of the vital centers of the brain by globules which escape through the pulmonary filter and not from any damage to the lung itself." It is estimated that in man the lethal dose of fat, administered intravenously, is about 150 gm. Sicard and Forestier (9) injected 2 to 4 c.c. of



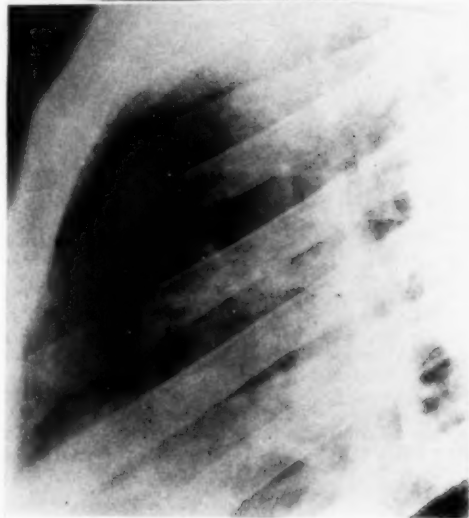


Fig 2. Detailed views of the upper part of the chest, July 15, 1948. At this time multiple small, fine, reticular densities were demonstrable in both lungs, apparently lying chiefly anteriorly. Unfortunately these do not reproduce very clearly.

lipiodol intravenously, very slowly, into the cubital vein in human subjects. Serial roentgenograms showed that it had reached the pulmonary capillaries within three to four seconds. It remained in the lung in the form of droplets for six to eight minutes, after which it suddenly disap-



Fig. 3. Roentgenogram of chest, June 7, 1950. The opaque emboli are no longer apparent. The chest appears normal.

peared. Cough without dyspnea was the only untoward symptom. These findings also indicate that fat embolism does not necessarily lead to pulmonary infarction.

It is surprising, in view of the frequent use of myelography, that there have been so few recorded cases of venous intravasation. The cerebrospinal fluid pressure is normally higher than the pressure of the vertebral venous system, so that, once a vein of the spinal cord or investing membranes is punctured or torn and communicates with the spinal fluid, one would expect the fluid and its contents to enter the circulatory system. There are two rich venous plexuses within the spinal canal: (1) the posterior internal plexus, which receives the basivertebral veins from the bodies; (2) the anterior internal plexus, which receives blood from the medulla and meninges. The two internal plexuses, which lie between the dura and bone, are linked by "venous rings," the *retia venosa vertebrarum*. Both plexuses communicate with the intervertebral veins which empty into the lumbar and lateral

sacral veins. These veins eventually empty into the inferior vena cava. Due to low venous pressure, the numerous bypasses and multiple communicating channels, the blood flow may be in any direction, depending upon the pressure changes (5). Thus with the rich network of small veins surrounding the cord and sub-arachnoid space, a bloody spinal tap is not unusual.

For roentgen visualization in the lungs, between 4 and 7.5 c.c. of pantopaque must enter the venous system. Hinkel's patient received approximately 3 c.c. intravenously and none was demonstrable on films of the chest. Our patient received an estimated 7.5 c.c., which cast a definite shadow in the lungs and was visible unchanged six days after the accident occurred. Approximately two years later the lungs appeared entirely normal. This is not in accord with Sicard and Forestier's experience with lipiodol, which they found had disappeared from the lung after eight minutes.

The roentgenogram of the chest is unusual in that the pantopaque emboli appear to lie chiefly in the anterior portion of the chest. The patient was in a prone position during the examination and the medium probably entered the vessels in the most dependent part of the chest due to the effect of gravity.

#### SUMMARY AND CONCLUSIONS

A case of pulmonary pantopaque emboli occurring during myelography is pre-

sented. This is the first case of pulmonary embolism due to this cause to be reported in the literature, although two cases of venous intravasation during myelography have been recorded.

Although all of the patients thus far reported have recovered after transient episodes of chest pain, non-productive cough, and fever, it is suggested that myelography be deferred temporarily if bloody spinal fluid is obtained after inserting the intraspinal needle.

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#### SUMARIO

#### Embolia Pulmonar por Pantopaco durante la Mielografía

El caso de émbolos pulmonares sobrevenidos durante la mielografía con pantopaco aquí presentado es el primero debido a dicha causa que aparezca en la literatura, aunque ya hay registrados dos casos de intravasación venosa durante la mielografía.

Si bien todos los enfermos descritos hasta ahora se han repuesto después de episodios pasajeros de dolor torácico, tos seca y fiebre, sugiérese que, en caso de obtener líquido raquídeo sanguinolento después de introducir la aguja intrarraquídea, se aplase temporalmente la mielografía.

## A Portable Cassette Changer for Angiography<sup>1</sup>

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Rochester, N. Y.

THE VALUE OF CONTRAST angiography in the examination of the brain and heart is now well established. The first procedures and apparatus were those described by Egas Moniz in 1927 for intracranial angiography and by Robb and Steinberg in 1936 for angiocardiology. Since then, these and closely related techniques have been gradually perfected, and

cassettes and a motor-driven mechanism to transport the cassettes automatically and to energize the x-ray tube. The complete unit, including the motor, measures  $40 \times 17 \times 13$  inches, and weighs 95 pounds.

The *film reservoir*, designated by H in Figure 1, is a framework with built-in elevator upon which ten cassettes can be loaded. A *knob* (G) allows the elevator to

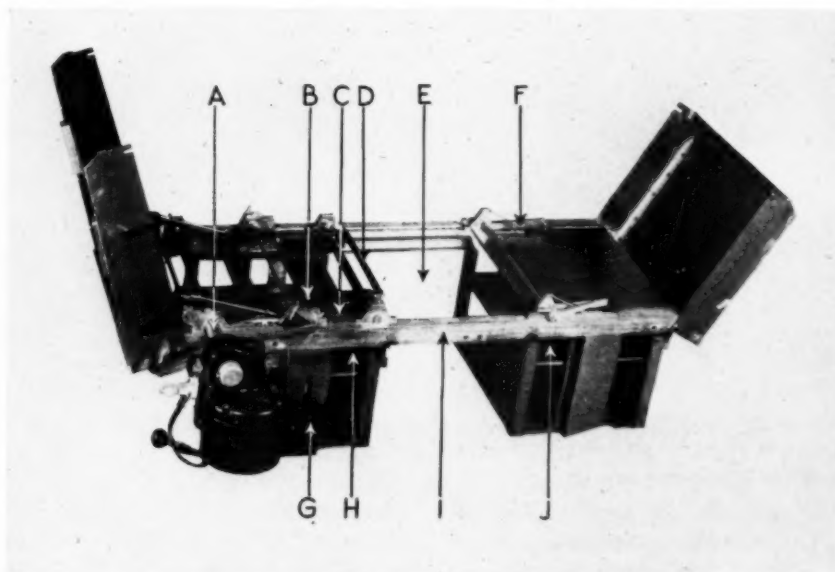


Fig. 1. Cassette changer with covers open to show working parts. See text.

many useful devices have been described in the literature. The development of these methods and apparatus has been well surveyed by Fineman (1), Campbell and Lockhart (2), and others.

The following is the description of a portable, fully automatic cassette changer for use in angiography. As shown in Figures 1 and 2, the apparatus consists, basically, of a reservoir and a receptacle for

be lowered prior to loading the cassettes. As the elevator is depressed, the framework in the *film receptacle* (J) rises by means of connecting rods in the horizontal *framework* (I).

Transfer of the cassettes that move from the film reservoir to the film receptacle is accomplished by the use of chains continuously moving in a counter-clockwise direction. *Rubber-covered bars* (D)

<sup>1</sup> From the Departments of Radiology of the Genesee Hospital and the University of Rochester School of Medicine and Dentistry, Rochester, N. Y. Accepted for publication in September 1950.

mounted across the chains engage the edges of the cassettes as they rise in the elevator. The first half-revolution of the chain transfers the cassette to the *center portion* (E), where the exposure is made when a small *projection* (B) from the chain makes contact with a *microswitch* (C). With the next half-revolution of the chain mechanism, the second cassette is transferred into the exposure position, pushing the previously exposed film onto the receptacle platform, which has been lowered automatically a distance equal to the thickness of the cassette. This depression of the platform in the film receptacle is produced

of two per second, and each cassette would remain motionless for one-twentieth of a second. The machine accommodates ten  $10 \times 12$ -inch cassettes, but can be made to operate with any lesser number by insertion of a platform of appropriate height in the film receptacle. Unloaded cassettes may be used for this purpose instead of a platform. At present, the changer operates on a  $1/8$  horsepower, 1725-RPM motor with worm-gear reduction, but experience has shown that a  $1/6$  horsepower motor would be more desirable.

Electrical connections consist of a two-button radiographic hand switch arranged

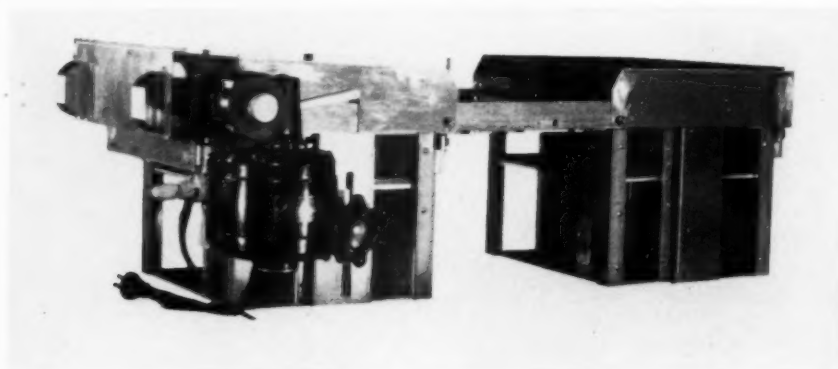


Fig. 2. Cassette changer with covers closed, ready for operation.

by a pair of *levers* (F) activated by the connecting rods in the horizontal framework. The process is repeated until all of the cassettes have been exposed and transferred into the film receptacle. The center portion has a lucite cover beneath which the cassettes travel. Provision is made for mounting a grid between the lucite cover and cassettes when, for any reason, this is desirable.

The length of the chains and the relation of the microswitch contactor to the transversely oriented, rubber-covered bars have been selected so that, when the films are exposed at the rate of one per second, each cassette pauses in the exposure position for approximately one-tenth of a second. If the speed of the drive shaft (A) were doubled, films would be exposed at the rate

so that one button activates the rotating anode of the x-ray tube and the other starts the motor on the cassette changer. In actual operation, the technician first pushes the button to start the rotation of the anode. Then, at a signal from the physician who is making the injection, the technician presses the second button to activate the changer mechanism. Figure 2 is a view of the changer with the top closed ready for use.

To summarize, the cassette changer described in this article possesses the following useful attributes:

1. It is light in weight, portable, of relatively small size, and uses standard cassettes. These features will appeal to the average size hospital unable to allocate a room full time for angiography.

2. The changer is readily adaptable to existing radiographic equipment

3. The fully automatic, motor-driven construction eliminates exposure of personnel, other than the physician making the injection, to scattered radiation.

4. Since the cassettes are moved independently of gravity, the device can be operated equally well in either a horizontal or upright position.

5. Films taken at the rate of one per second have proved satisfactory for most examinations. The frequency may be changed, however, by varying the speed of the drive shaft.

6. Up to ten films may be exposed with one loading of the mechanism.

ACKNOWLEDGMENT: The changer described here was designed with the help of and was wholly constructed by Mr. A. J. Gibson of the Department of Physics, University of Rochester, Rochester, N. Y.

224 Alexander Street  
Rochester, N. Y.

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2. CAMPBELL, J. A., AND LOCKHART, P. B.: Improved Vertical and Horizontal Multiple Cassette Changers for Contrast Angiography. *Radiology* **54**: 559-566, April 1950.

#### SUMARIO

##### Cambia-Chasis Portátil para la Angiografía

El cambia-chasis aquí descrito para empleo en la angiocardiógrafa es portátil y absolutamente automático. Consta, fundamentalmente, de un depósito y un receptáculo para chasis y un mecanismo impulsado por motor que transporta automáticamente los chasis y energiza el tubo de rayos X. El aparato completo, el motor inclusive, mide  $100 \times 42.5 \times 32.5$  cm. y pesa unos 43 kg. Puede adaptarse fácilmente a las corrientes instalaciones radiográficas y funciona igualmente bien ya horizontal o verticalmente.

Las radiografías tomadas a razón de una por segundo han resultado satisfactorias para la mayor parte de los exámenes. Sin embargo, puede modificarse la frecuencia, variando la velocidad del árbol del impulsador. Con una sola carga del mecanismo pueden exponerse hasta diez radiografías.

La construcción absolutamente automática y el impulso por motor eliminan la exposición del personal a la irradiación esparcida, exceptuado el médico que ejecuta la inyección.





# EDITORIAL

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## Atomic Bomb Defense

Conference of Teachers of Clinical Radiology

The threat of atomic warfare has loaded us radiologists with a grave responsibility. We are the only large group of physicians with a specialist's understanding of radiation injuries. We can expect to be called upon by our medical confreres for consultation and action in this field, by civil defense authorities in planning, and by everyone at the time of atomic bombing, should such ever be inflicted on this foolish world. We can predict something of the magnitude of the problems and we had better be prepared.

The American College of Radiology appears to feel that it is *in loco parentis* toward all radiologists, if such a feudal notion is applicable to a democratic organization. They initiated last year a correspondence course in atomic defense, by which they attempted (a) to arouse the membership (about 3,000 radiologists) to their unique status in this field, (b) to educate them and indoctrinate them as to the factual basis and advisable defense measures in a dozen easy lessons, (c) to motivate them further into actually studying these lessons by follow-up post-card quizzes. This is still going on. Undoubtedly the actual activity at the level of the recipient radiologist is widely fluctuant according to geography and the momentary emotional level induced by newspaper headlines. This activity of the College has no doubt been taken by many of the members to be pretty stuffy. Assigned lessons always have been distasteful medicine, and whether it has been divided this time into small enough spoonfuls so that it is not quite all spit out remains to be seen.

But that is not the end of the efforts of

the College. Their entire Annual Teachers' Conference (the eighteenth) last February was turned over to this problem of atomic defense, in an attempt to arouse the teachers of radiology to the enlarging obligations in undergraduate and graduate medical education. It may be more realistic to try to effect the desirable expansion by teaching the teachers than by the amateur correspondence courses above mentioned. But the teachers are working only on the upcoming crop of radiologists and do not reach those already established in practice.

The team of essayists that the College mobilized for this Teachers' Conference was full of knowledge and persuasive power. Their essays are published in this issue of RADIOLOGY.

Dr. W. H. Aufranc, Acting Director of the Health Resources Office, explained the organization and the liaison with interested groups for all the activities concerned: calling up doctors to duty; forwarding training for nurses' aides, home aid and first aid; hastening the education of physicians and nurses; procurement and stockpiling of medical supplies and of blood and plasma; etc. What a multifarious activity! One could hardly get it all into one's head.

General James P. Cooney continued his campaign for doctors' understanding of the nature of atomic warfare, the proper evaluation of radiation hazards along with the other hazards, and the duties of the medical profession after an atomic bombing. He has long recognized the need of education to forestall panic.

General Elbert DeCoursey, Director of the Armed Forces Institute of Pathology,

gave an intimate illustrated review of the damage done by atomic radiation. Much of his material was from Bikini.

Commander Eugene P. Cronkite told about the lethal effects of radiation on animals and the methods available to prevent and cure them. Too bad radiation injuries seem not very amenable. Dr. Cronkite has irradiated great numbers of small animals and large ones at the Naval Medical Research Institute at Bethesda, and also put rats and pigs and goats out for exposure at Bikini.

Dr. William F. Bale, of the Biophysics Branch of the Atomic Energy Commission, told about instruments and technics for detection of radiation hazards and their evaluation. He said that orders for the presently accepted gamma ray instrument could be pooled to get a better price. Also that ideal specifications were to be set before manufacturers to stimulate competitive production.

Dr. Claude R. Schwob, Chief of the Chem-

istry Branch, U. S. Naval Radiological Defense Laboratory at Hunters' Point in San Francisco, explained the philosophy, technics, and success of decontamination. At Hunters' Point they had some of the well contaminated ships from Bikini to work on. The last one, the flat-top "Independence," was only recently taken out to sea and sunk.

Admiral C. F. Behrens, Director of the Naval Medical Research Institute at Bethesda, kindly added some pertinent remarks and answered some searching questions along with the essayists during the discussion which followed the afternoon session.

The matter is so important, so immediately and emotionally important, that it is a valuable service to get these authoritative opinions thus promptly before us radiologists, who of all medical men are best adapted to appreciate them and most likely to be called on to use them.

R. R. NEWELL, M.D.

## Presidential Address

### Conference of Teachers of Clinical Radiology

There was a time when the physician had only to concern himself with the practice of medicine; when medical societies were organized only for scientific development. This was both fortunate and unfortunate—fortunate in that it succeeded in establishing the greatest system of medicine that the world so far has known; unfortunate in that we paid little attention to anything else. We took no interest in politics or other civic enterprises. We were a group apart, leaving the future often in far less capable hands, unaided and ignored by us. We were content to practise medicine, and we still would be, but that the developments of the past few years have left us all with a feeling of insecurity. For the sake of our country, it

has become obvious that we must do more. We, along with our neighbors in all walks of life, are threatened by a conquest by communism. This demands that every man arise to face the situation and be counted among the defenders of our American way of life.

This possible catastrophic world conflict puts an added burden and responsibility on everyone, but especially on every medical man and medical organization. In times of war or impending war we will be expected to undertake the task of caring for both the military and civilian medical needs including the continued operation of our medical schools and hospitals, none of which can be too greatly curtailed. That the medical profession will arise to

this emergency is apparent from past performances.

It need not be repeated that the men and women in service deserve the best in medical care, but so that we may accomplish our job we must demand that the national government induct no more doctors into the Armed Services than are actually needed. Trained physicians are too valuable to have either their time or talent thoughtlessly wasted. We had hoped that there would be a complete unification of medical services for the Armed Forces. This undoubtedly would conserve a lot of medical manpower, avoiding needless duplication of services—in other words, the treatment of a soldier, airman, or sailor, once he gets back to a base hospital, is the same, regardless of the color of his uniform. This still might be accomplished by vigorous recommendations from our organized medical groups. There are many other short-cuts to economy of medical care and manpower which have already been brought to the attention of the Armed Services. What happens to these suggestions remains to be seen.

On the home front, we are committed to continue our efforts for the orderly development of medical practice and ever improving and spreading the coverage of our own sickness insurance plans. We must insure as many millions of people as rapidly as possible in the voluntary plans for good medical and hospital care in order to curtail increased government bureaucracy and ultimate national socialization. It is clear that medicine has been chosen as the entering wedge. The voluntary health insurance plans, while they are still imperfect and do not hold all the answers to medical care, should serve as examples, pointing to the way that people can help themselves instead of ever turning to the government. It is to be hoped that more physicians will take an active interest in this development; too few have made any effort either to understand the plans, or to co-operate with them. I recognize that there is a place for government in medicine

and I would not have my remarks misinterpreted. The public health departments deserve highest praise. One has only to travel abroad to appreciate our system of sanitation and public health, but further extension of government in the field of private medical practice should come only as a result of voluntary co-operation between government and the medical organizations, not be forced on medicine through government propaganda.

I have already mentioned medical education and we may hope to continue this magnificent development, but the private medical schools are in financial difficulties. A solution of this problem has been started by the American Medical Association with an appropriation of \$500,000 for direct aid to medical schools. I understand this has grown to \$750,000 since December 1950, when the appropriation was made. These things are being mentioned to remind you and a great many others that private organizations and individuals can do many things for themselves, oftentimes more inexpensively and easily than through government. There must, however, be a will to put forth the necessary effort.

We physicians also have a responsibility to aid in the education of the people and our fellow physicians whenever such a need becomes apparent. This meeting today is an effort on the part of the American College of Radiology to bring facts to radiologists and others on the effects of an atomic attack. The meeting was scheduled with the knowledge that this potential catastrophe affects us all. We believe that it is our duty to make available this information to as many people as possible so that we and they may act intelligently and calmly, co-operating with all others in the organized teams for civilian defense. This is a part of being citizens as well as physicians, offering one's services before they have been demanded in an attempt to save individual lives and the nation from possible hysteria and chaos. The interest which you have shown in this program by your presence should not end here; we

hope that you will not only teach others in our medical schools what you have learned, but will offer your services to perfect the civilian defenses in the communities to which you return.

Lastly, I would like to take this opportunity to say that I do not believe we should give way to despair and gloom over the future. I am not going to tell you not to worry—someone has said that he who does not worry in the face of all of our mechanical developments and the state of American traffic probably will not live

long—but I would exhort you to worry intelligently. We are a great nation; we have faced and overcome great dangers and potential disasters many times in the past. We can overcome this possible disaster by working as a team, with everyone doing his part unselfishly and willingly. It is a time to consider our own services and to remember the Biblical quotation, "Whosoever will be great among you shall be servant of all." Observing this, and with the aid of our own common sense, I feel sure we shall not fail.

C. EDGAR VIRDEN, M.D.



## ANNOUNCEMENTS AND BOOK REVIEWS

### ATLANTA RADIOLOGICAL SOCIETY

At the March meeting of the Atlanta (Georgia) Radiological Society the following officers were elected: President, Albert Rayle, Sr., M.D.; Vice-President, Leonard Long, M.D.; Secretary-Treasurer, J. Dudley King, M.D., 35 Linden Ave., N. E., Atlanta.

### NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

A recent addition to the regional radiological societies is that of Northeastern New York. This society was established in Albany, N. Y., and plans to hold three of its quarterly meetings in that city. The June meeting will be held elsewhere in the state. The officers for the present year are Dr. Edward DeFeo, President; Dr. Orville L. Henderson, Vice-President; Dr. John F. Roach, Albany Hospital, Secretary-Treasurer.

### OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

Three additional basic courses in radioisotope technics of four weeks duration and a three-week autoradiography course will be offered this summer by the Special Training Division of the Oak Ridge Institute of Nuclear Studies.

The basic courses are scheduled to begin on June 11, July 9, and Aug. 15. The courses combine lectures, demonstrations, and laboratory work. Sufficient space is available to permit individual laboratory work. Thirty-two participants will be accepted for each course.

The autoradiography course, which will begin on July 2, will be the first of its kind to be offered by the Institute. It is intended for personnel who will direct medical or biological research utilizing the autoradiographic process. George A. Boyd, formerly of the University of Rochester, who is well known for his work in autoradiography, will be the director. Twenty participants will be accepted for the course.

Registration is \$25.00 for each course. Additional information and application forms are available from Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

## Letter to the Editor

To the Editor of *Radiology*

DEAR DR. DOUB:

I am taking the liberty of writing you in reference to a paper on "Chorionepithelioma of the Uterus"

by Drs. Levi and Haig, appearing in *RADIOLOGY* for January 1951, in which they state that no detailed accounts of this tumor treated by radiation have appeared in the American literature.

Actually, nearly twenty years ago I reported such a case in the *Boletín de la Sociedad de Cirugía de Chile* (10: 335, December 1932). The patient was a woman of forty-six with a history of two normal deliveries and three miscarriages. In November 1931 she had a spontaneous abortion with abundant hemorrhage. Curettage was done and the pathologist (Professor Croizet of the Faculty of Medicine of the University of Chile) made a diagnosis of chorionepithelioma. On being called into consultation, I found adjacent to a large uterus two masses representing the enlarged ovaries. As the patient was very anemic and her general condition was poor, it was felt that a radical operation was contraindicated. Accordingly she was given three transfusions and roentgen therapy was instituted, with the following factors: 200 kv., 10 ma., 60 cm. target-skin distance, and 1.0 mm. Cu filter. Treatment was given to one posterior, one anterior, and two lateral fields, the posterior and anterior measuring  $15 \times 12$  cm., and the lateral fields  $10 \times 10$  cm. The daily dose was 300 r and the total about 7,500 r according to present-day dosimetry. The uterus and ovaries rapidly diminished in size, and two months later operation was performed at the request of the family physician. The same pathologist who had previously made the diagnosis of chorionepithelioma examined the removed uterus and reported the finding of necrobiotic cells alternating with new fibrous tissue and new blood vessels. The patient, now sixty-five years of age, remains in perfect health.

Five more cases have been treated at the Institute of Radium, including one with metastasis to the upper femoral epiphysis. This latter patient was given roentgen therapy through three portals, anterior and posterior ( $15 \times 15$  cm.) and one lateral ( $12 \times 12$  cm.), over a period of four weeks, receiving 350 r daily for a total dose of 12,000 r (250 kv., 15 ma.). She has been well since 1943. One other patient in this group is still alive after three years. The remainder died of generalized disease.

More recently (August 1950) I have treated still another case. This patient was thirty-two years of age, with a history of two normal pregnancies. She had an abortion in April 1950, followed by curettage for excessive bleeding. She remained well until August, when she started to cough and to lose weight. Hemoptysis occurred and a shadow was demonstrated in the lower lobe of the left lung. A thoracic surgeon did a lobectomy, and a pathologic diagnosis of chorionepithelioma was made. A few days after the operation, there was a recurrence of



vaginal bleeding with pain, and a large mass was found occupying almost the entire pelvis. Roentgen therapy was then given (400 kv.) through an anterior and a posterior portal, each receiving a total dose of 4,500 r in five weeks. The tumor shrank rapidly, but in November a painful mass appeared in the left hypochondrium. It could not be determined whether this was an infarction of the spleen, a metastasis, or lymph nodes. Since I was unwilling to irradiate the spleen, having observed for years what Jacobson has more recently proved, namely, that irradiation of the spleen is too toxic (Jacobson, L. O.: Fifth International Cancer Congress, Paris, July 1950), I tried nitrogen mustard, 0.12 mg. per kilo. Five injections of 0.48 mg. each were given. The Aschheim-Zondek reaction, which had been highly positive, became negative, the masses in the pelvis and hypochondrium disappeared, and the case was now regarded as operable. In December, exploration was undertaken. No lymphatic, splenic, or hepatic mass was discovered. The uterus was enlarged and necrotic throughout about two-thirds of its volume. It was removed with the enlarged ovaries. The pathologist reported the presence of some chorionepithelial cells, in spite of the negative Aschheim-Zondek reaction. In March 1951 the reaction was still negative and the patient was doing well.

I am glad operation was done in this last case, as I believe otherwise peritonitis might have ensued. I wonder if nitrogen mustard has been used by anyone else in chorionepithelioma and with what result.

I shall greatly appreciate it if you can publish this note in *RADIOLOGY*.

Yours very truly,  
DR. LEONARDO GUZMÁN  
Institute of Radium  
Santiago, Chile

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**ABDOMINAL DISTENTION AND INTESTINAL ACTIVITY FOLLOWING LAPAROTOMY. A STUDY OF THE "POSTOPERATIVE ABDOMEN," ESPECIALLY THE ROENTGENOLOGICAL FINDINGS AFTER HERNIOTOMY, APPENDECTOMY AND GYNECOLOGICAL OPERATIONS.** Acta Radiologica Supplement 83. By ANDREAS HØYER. From the Oslo Municipal Hospital Ullevål, Surgical Department III (Head: Carl Semb, M.D.) and Roentgenological Department (Head: Johan Frimann-Dahl, M.D.), Oslo, Norway. A monograph of 208 pages, 34 figures, 55 tables. Published by Nationaltrykkeriet, Oslo, 1950. Price Sw. Cr. 15.

**DIE ENTZÜNDUNGSBESTRAHLUNG.** By DR. MED. HABIL R. GLAUNER, Dozent für Röntgenologie und Strahlenheilkunde, Chefarzt der Röntgenabteilung am Marienhospital, Stuttgart. A volume of 190 pages, with 17 illustrations and 10 tables. Published by Georg Thieme, Stuttgart, 2d ed., 1951. Price \$4.45. Distributed in U. S. A. by Grune & Stratton, 381 Fourth Ave., New York 16, N. Y.

**LEHRBUCH DER RÖNTGENDIAGNOSTIK.** By H. R. SCHINZ, W. E. BAENSCH, E. FRIEDL, E. UEHLINGER, with contributions by E. BRANDENBERGER, A. BRUNNER, U. COCCHI, N. P. G. EDLING, J. EGGERT, F. K. FISCHER, M. HOLZMANN, H. KRAYENBÜHL, Å. LINDBOM, E. LINDGREN, G. A. PREISS, S. WELIN, AND A. ZUPPINGER, Vol. I. The Skeletal System. Part III. A volume of 528 pages, with 732 illustrations. Published by Georg Thieme, Stuttgart, 5th completely revised edition, 1951. Sole distributors for U. S. A. and Canada: Grune & Stratton, Inc., 381 Fourth Ave., New York 16, N. Y. Price \$19.50.

## Book Reviews

**A TEXT-BOOK OF X-RAY DIAGNOSIS.** By British Authors. In four volumes. Edited by S. COCHRANE SHANKS, M.D., F.R.C.P., F.F.R., Director, X-Ray Diagnostic Department, University College Hospital, London, and PETER KERLEV, M.D., F.R.C.P., F.F.R., D.M.R.E., Director, X-Ray Department, Westminster Hospital; Radiologist, Royal Chest Hospital, London. Vol. III. **THE ABDOMEN.** A volume of 830 pages, with 694 illustrations. Price \$18.00. Vol. IV. **BONES, JOINTS, AND SOFT TISSUES.** A volume of 592 pages, with 553 illustrations. Published by W. B. Saunders Co., Philadelphia, 2d ed., 1950. Price \$15.00.

Volumes III and IV, the first two of four to be published, introduce the second edition of the well known Text-Book of X-Ray Diagnosis by British Authors. Long awaited because of the delay occasioned by the war, this second edition promises to take the same authoritative position as a reference work on diagnostic radiology as its predecessor. The set of four volumes is intended to present a comprehensive survey of current thought and knowledge in radiologic diagnosis. The reviewer believes the purpose has been successfully accomplished in the first two volumes at hand, which are not at the present surpassed by any text in English.

Volume III, *Abdomen*, is divided into six parts. Part I, covering the alimentary tract, begins with radiography of the salivary glands and concludes with a discussion of the x-ray appearance of the anorectal region in health and disease. An important and well written chapter on the postoperative stomach and duodenum, 36 pages in length

and containing diagrams of surgical procedures and postsurgical roentgenograms, attests the completeness of the work. A separate chapter defines and illustrates the gastro-intestinal diagnostic problems peculiar to children, but in comparison to the discussion of the adult findings this section seems brief. For example, no mention is made of meconium ileus, and the presentation of intussusception covers only the acute case with obvious clinical signs, though the more insidious case with a paucity of clinical signs demands greater acumen on the part of the radiologist.

Part 2 comprises the anatomy, physiology, and radiographic diagnosis of diseases of the biliary tract. Concerning the clinical correlation of the filling and non-filling gallbladder the author steers a wise neutral course and cites the current opinions in the literature as sources of thought for the reader. Parts 3 and 4 are concerned with the soft structures of the abdomen and obstetrical radiology respectively. Both fields of endeavor are well organized and illustrated.

Part 5, gynecological radiology, is chiefly an illuminating discussion of normal and abnormal hysterosalpingograms and certainly is one of the better coverages of the subject in current texts. Part 6, the radiology of the urinary tract, while adding little new, presents forthrightly the radiologic aspects of the genito-urinary tract in a compact and unified section.

Volume IV, *Bones, Joints and Soft Tissues*, offers a similar logical approach to radiologic diagnosis. Sections on normal radiologic anatomy of the skeletal system and general pathology of bone are followed by full discussions of deformities and diseases. The grouping of the material is based upon an etiologic and pathologic background. Congenital deformities, traumatic lesions, inflammatory diseases, static and paralytic lesions, the intervertebral disks, constitutional diseases of bones and joints, tumors and cysts are the headings of the principal divisions. Each of the major groups is subdivided into etiologic or pathologic subgroups. To illustrate, the section on constitutional diseases of bones and joints contains chapters on disturbances of growth, nutrition, metabolism and endocrine secretion, on bone and joint changes associated with toxic conditions, blood diseases, carcinomatosis and multiple myeloma, and diseases of unknown origin.

In the section devoted to static and paralytic conditions are well illustrated presentations on the intervertebral disks, spondylolisthesis, and orthopedic operations. This latter topic is well chosen to bridge the gap between the films on the view box and the ever progressive engineering of the orthopedic surgeons.

Clinical correlation is made throughout the book, but increased stress might have been placed on a tabular presentation of differential diagnostic features, particularly chemical, in those diseases in which definitive diagnosis is occasionally difficult.

A case in point would be Paget's disease of the pelvis and carcinoma of the prostate invading the pelvis. The student and younger radiologist would derive benefit from such handling. The section on tumors and cysts of bone at first seems brief when compared to the voluminous material currently published on the subject. This, however, is more the result of careful integration of material rather than exclusion, and the ensuing presentation is markedly improved.

The final section of this volume is a fully illustrated survey of the roentgenology of the peripheral soft tissues. A short chapter on foreign body localization describes general principles but omits the methods in common use for intraocular foreign body localization. However, since these technics are readily available in other standard publications, the exclusion is not a serious one.

The format is pleasing and the paper and binding are of good quality. Reproductions of radiographs are made in the negative phase relative to the customary film viewing practice, but the reviewer does not feel this will disturb the serious reader, and the greater amount of detail reproduced on the printed page by this technic more than offsets the lack of convenience. The series of four volumes should provide an authoritative and unified reference source for all radiologists.

**THERAPEUTIC RADIOLOGY.** By GEORGE WINSLOW HOLMES, M.D., Radiologist, Waldo County General Hospital, Maine; Honorary Physician, Massachusetts General Hospital; Radiologist-in-Chief, Massachusetts General Hospital, 1916-1941; Clinical Professor of Roentgenology, Emeritus, Harvard Medical School, and MILFORD D. SCHULZ, M.D., Radiologist, Massachusetts General Hospital; Instructor in Radiology, Harvard Medical School. A volume of 348 pages, with 121 illustrations, 10 in color. Published by Lea & Febiger, Philadelphia, 1950. Price \$7.50.

In this modest volume the authors attempt to present a comprehensive review of the principles and practice of therapeutic radiology. It is designed essentially for the medical student and the practitioner in the general field of radiology and is not intended as an exhaustive treatise for the specialist in therapy. The wide clinical experience of the authors, derived from association with the Massachusetts General Hospital Tumor Clinic—in the case of the senior author over many years—gives special weight to their observations.

The first three chapters, covering the early history of radiation therapy, elementary physics, and the biological effects of roentgen rays, form a sort of background for the subsequent consideration of clinical problems. They are followed by a chapter on treatment planning and execution, and another on selection, preparation, and care of patients, after which the diseases of the various anatomic

areas of the body are considered separately. A chapter on protection and on the medicolegal aspects of therapeutic radiology complete the work.

The use of hormonal therapy in malignant diseases is discussed in connection with the conditions where this is indicated, and the use of radioisotopes is considered briefly in appropriate connections.

It is obvious from even a cursory review that the volume is devoted mainly to roentgen therapy. This is explained by a paragraph in the introduction: "The authors realize that for the specialist in radiotherapy skill and experience in the use of radium as well as x-ray is imperative. To keep the scheme of procedure from becoming too involved for the student and general practitioner of radiology and to avoid controversy, reference to the use of radium has been limited in this book to those procedures in which it is ancillary. Whenever radium and x-ray seem to be alternative procedures, the method described has been the one using roentgen therapy. For those who wish to improve themselves in the use of radium further reading is suggested. Reading alone, however, will not serve. Effective use of radium requires the development of considerable manual skill and constant experience in addition to a knowledge of the general concepts, principles, rules, and methods of radium therapy."

The book is recommended as a valuable exposition, in concise form, of the cardinal principles of radiotherapy. It will be especially useful as a textbook for the beginner and as a source of ready reference in every-day radiotherapeutic practice.

**DIAGNOSIS AND TREATMENT OF TUMORS OF THE HEAD AND NECK (NOT INCLUDING THE CENTRAL NERVOUS SYSTEM).** By GRANT E. WARD, M.D., D.Sc., F.A.C.S., JAMES W. HENDRICK, M.D., M.S., and ALFRED BLALOCK, M.D. From the Departments of Surgery of the School of Medicine, University of Maryland, and the Johns Hopkins University School of Medicine, and the Oncology Clinic of the University Hospital and the Tumor Clinic of the Johns Hopkins Hospital. A volume of 832 pages, with 637 figures and 9 color plates. Published by Williams & Wilkins Co., Baltimore, Md., 1950. Price \$15.00.

As rapid strides in modern medicine are being made, each small area of human anatomy becomes a more extensive field and we must know more and more about less and less. This large volume is an example on the present trend of including all available information on a limited subject under one cover. The book is concerned with tumors of the head and neck other than intracranial structures.

The most important feature is the pronounced emphasis on a complete analysis of each problem to include the accepted methods of treatment. The

approach, however, is primarily surgical, and actual outlines of radiation therapy are not given.

The text is well written, for easy, understandable reading. It is printed on good glossy paper, with a wealth of fine photographs, roentgenograms, and drawings to illustrate important features of each type of tumor. This book is an excellent adjunct to the radiotherapist's reference library, not as an outline of radiation treatment of head and neck tumors, but as a tumor board type of discussion.

**A MANUAL OF ARTIFICIAL RADIOISOTOPE THERAPY.** Edited by PAUL F. HAHN, Cancer Research Laboratories, Meharry Medical College, Nashville, Tenn. A volume of 310 pages, with numerous illustrations and tables. Published by the Academic Press, Inc., New York, 1951. Price \$6.80.

This manual has been prepared for radiologists and others who are interested in the practical application of radioisotopes to the study and therapy of disease processes. It is the work of a number of authorities well known to readers of *RADIOLOGY*. Dr. Hahn, the editor, has himself contributed the chapters on Criteria for the Use of Therapeutic Isotopes, Radioactive Colloids in the Treatment of Lymphoid-Macrophage Diseases, and Tumor Therapy by Direct Infiltration of Radioactive Colloidal Metallic Gold.

Many of the chapters do not require an extensive knowledge of physics for their understanding, but for those on Terminology and Standards (by Robley D. Evans) and Dosimetry (by Edith H. Quimby) some background in that basic science is essential.

Other chapters concern the treatment of polycythemia vera by radiophosphorus, by Charles F. Stroebel and Byron E. Hall; radioactive iodine in the study and treatment of hyperthyroidism, by John B. Hursh and John W. Karr, and of carcinoma of the thyroid, by Rulon W. Rawson and Jack B. Trunnell; the radioisotope program in the hospital, by Edith H. Quimby and Carl B. Braestrup. The problems of instrumentation in a therapeutic program are discussed by Raymond L. Weiland, problems of protection by Karl Z. Morgan, the availability of isotopes and means of procurement by P. C. Aebersold, and autoradiography as a medical research tool by Leblond and Gross.

As emphasized by Andrew H. Dowdy in his introduction, these chapters serve both to emphasize the complexities of radiation therapeutic problems and to indicate the progress which is being made through the cooperative type of approach. The work is a valuable reference source for those interested in practical isotope therapy in its present stage of development.

## RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

*Editor's Note:* Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

**RADIOLOGICAL SOCIETY OF NORTH AMERICA.** *Secretary-Treasurer,* Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

**AMERICAN RADIUM SOCIETY.** *Secretary,* John E. Wirth, M.D., 635 Herkimer St., Pasadena 1, Calif.

**AMERICAN ROENTGEN RAY SOCIETY.** *Secretary,* Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

**AMERICAN COLLEGE OF RADIOLOGY.** *Exec. Secretary,* William C. Stronach, 20 N. Wacker Dr., Chicago 6.

**SECTION ON RADIOLOGY, A. M. A.** *Secretary,* Paul C. Hodges, M.D., 950 East 59th St., Chicago 37.

### Alabama

**ALABAMA RADIOLOGICAL SOCIETY.** *Secretary-Treasurer,* W. D. Anderson, M.D., 420 10th St., Tuscaloosa.

### Arizona

**ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS.** *Secretary,* R. Lee Foster, M.D., 507 Professional Bldg., Phoenix.

### Arkansas

**ARKANSAS RADIOLOGICAL SOCIETY.** *Secretary,* Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

### California

**CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY.** *Secretary,* Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

**EAST BAY ROENTGEN SOCIETY.** *Secretary,* Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

**LOS ANGELES RADIOLOGICAL SOCIETY.** *Secretary,* Harold P. Tompkins, M.D., 658 South Westlake Ave. Meets monthly, second Wednesday, County Society Bldg.

**NORTHERN CALIFORNIA RADIOLOGICAL CLUB.** *Secretary,* Clifford W. Wauters, 701 High St., Auburn. Meets at dinner last Monday of September, November, January, March, and May.

**PACIFIC ROENTGEN SOCIETY.** *Secretary,* L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

**SAN DIEGO ROENTGEN SOCIETY.** *Secretary,* R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

**X-RAY STUDY CLUB OF SAN FRANCISCO.** *Secretary,* Merrell A. Sisson, M.D., 450 Sutter St., San Francisco 8. Meets third Thursday at 7:45, January to June at Stanford University Hospital, July to December at San Francisco Hospital.

### Colorado

**COLORADO RADIOLOGICAL SOCIETY.** *Secretary,* Paul E. RePass, M.D., 306 Republic Bldg., Denver 2. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

### Connecticut

**CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY.** *Secretary,* Fred Zaff, M.D., 135 Whitney Ave., New Haven. Meets bimonthly, second Wednesday.

**CONNECTICUT VALLEY RADIOLOGICAL SOCIETY.** *Secretary,* Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

### District of Columbia

**RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY.** *Secretary,* Karl C. Corley, M.D., 1835 Eye St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Auditorium.

### Florida

**FLORIDA RADIOLOGICAL SOCIETY.** *Secretary-Treasurer,* Nelson T. Pearson, M.D., 1109 Huntington Bldg., Miami. Meets in April and in November.

**GREATER MIAMI RADIOLOGICAL SOCIETY.** *Secretary,* Theodore M. Berman, M.D., 350 Lincoln Road, Miami Beach. Meets monthly, last Wednesday, 8:00 P.M., in the Veterans Administration Bldg., Miami.

### Georgia

**ATLANTA RADIOLOGICAL SOCIETY.** *Secretary-Treasurer,* J. Dudley King, M.D., 35 Linden Ave., N. E. Meets second Friday, September to May.

**GEORGIA RADIOLOGICAL SOCIETY.** *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Americus. Meets in November and at the annual meeting of State Medical Association.

### Illinois

**CHICAGO ROENTGEN SOCIETY.** *Secretary,* Benjamin D. Braun, M.D., 6 N. Michigan Ave., Chicago 11. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

**ILLINOIS RADIOLOGICAL SOCIETY.** *Secretary-Treasurer,* William DeHollander, M.D., St. John's Hospital, Springfield. Meets quarterly as announced.

**ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY.** *Secretary,* Willard C. Smullen, M.D., St. Mary's Hospital, Decatur.

### Indiana

**INDIANA ROENTGEN SOCIETY.** *Secretary-Treasurer,* William M. Loehr, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

### Iowa

**IOWA X-RAY CLUB.** *Secretary,* Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.



**Kansas**

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Anthony F. Rossitto, M.D., Wichita Hospital, Wichita. Meets annually with State Medical Society.

**Kentucky**

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel.

**Louisiana**

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday.

**Maine**

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Clark F. Miller, M.D., Central Maine General Hospital, Lewiston.

**Maryland**

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, J. Howard Franz, M.D., 1127 St. Paul St., Baltimore 2.

**Michigan**

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

**Minnesota**

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, Leo A. Nash, M.D., 572 Lowry Medical Arts Bldg., St. Paul 2. Meets in Spring and Fall.

**Missouri**

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Wm. M. Kitchen, M.D., 1010 Rialto Building, Kansas City 6, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Donald S. Bottom, M.D., 510 S. Kingshighway Blvd. Meets on fourth Wednesday, October to May.

**Nebraska**

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Russell W. Blanchard, M.D., 1216 Medical Arts Bldg., Omaha. Meets fourth Thursday of each month at 6 P.M. in Omaha or Lincoln.

**New England**

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, L. L. Robbins, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday at the Harvard Club, Boston.

**New Hampshire**

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meets quarterly in Concord.

**New Jersey**

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Peter J. Gianquinto, M.D., 685 High St., Newark 2. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

**New York**

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary*, J. Daversa, M.D., 603 Fourth Ave., Brooklyn. Meets fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meets in January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to May, at 8:45 P.M., Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, John L. Olpp, M.D., 49 Ivy Lane, Tenafly, N. J.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets quarterly.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, George Gamsu, M.D., 191 S. Goodman St. Meets at Strong Memorial Hospital, last Monday of each month, September through May.

**North Carolina**

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

**North Dakota**

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, P. H. Woutat, M.D., 322 Demers Ave., Grand Forks.

**Ohio**

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Edward C. Elsey, M.D., 927 Carew Tower, Cincinnati 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Hannan, M.D., 10515 Carnegie Ave., Cleveland 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Lawrence Gibboney, M.D., Carew Tower Bldg. Meets first Monday, September to May.



MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Geo. A. Nicoll, M.D., Miami Valley Hospital, Dayton. Meets monthly, second Friday.

#### Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

#### Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. Todd Jessell, M.D., 224 Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, at 8:00 P.M., University of Oregon Medical School.

#### Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

#### Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Conyerse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., American Oncologic Hospital, Philadelphia 4. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Edwin J. Euphrat, M.D., 3500 Fifth Ave., Pittsburgh 13. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

#### Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr. Next annual meeting, Aug. 9-11, 1951, Denver.

#### South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, S. H. Fisher, M.D., 107 E. North St., Greenville. Meets with State Medical Association in May.

#### South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Marianne Wallis, M.D., 1200 E. Fifth Ave., Mitchell. Meets with State Medical Society.

#### Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, John E. White-leather, M.D., 809 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

#### Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meets monthly third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg., Houston 5.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting, Jan. 18-19, 1952, Houston.

#### Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

#### Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk.

#### Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. C. Kiltz, M.D., 705 Medical-Dental Bldg., Everett. Meets fourth Monday, October through May, at College Club, Seattle.

#### Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee. Meets in May and with State Medical Society, September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving I. Cowan, M.D., 425 East Wisconsin Ave., Milwaukee 2.

#### CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Jean Bouchard, M.D. Assoc. Hon. Secretary-Treasurer, D. L. McRae, M.D. Central Office, 1555 Summerhill Ave., Montreal 26, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

#### CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

#### MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA. *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, Mexico, D. F. Meets first Monday of each month.

#### PANAMA

SOCIEDAD RADIOLOGICA PANAMENSA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

#### PUERTO RICO

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542, Santurce, Puerto Rico.

## ABSTRACTS OF CURRENT LITERATURE

### ROENTGEN DIAGNOSIS

#### The Head and Neck

- LEGER, JEAN-LOUIS. Cerebral Angiography..... 757
- SCHLESINGER, BENNO. Gliomas Involving the Splenium of the Corpus Callosum. A Roentgenologic Study..... 757
- JÉQUIER, MICHEL. Myotonic Dystrophy and Cranial Hyperostosis..... 757
- LAKE, MAX S., AND KUPPINGER, JOHN C. Craniofacial Dysostosis (Crouzon's Disease)..... 757
- CONVERSE, JOHN M., AND SMITH, BYRON. Reconstruction of the Floor of the Orbit by Bone Grafts..... 757

#### The Chest

- MILLER, JOSEPH B., ET AL. A Simple, Safe Bronchographic Technique for Children.... 758
- BROWN, NORMAN M. Ioduron B: A Water Soluble Contrast Medium for Bronchography.. 758
- PEABODY, HOMER D., JR., AND SUNDBERG, R. H. Detection of Pulmonary Tuberculosis. Comparative Value of Routine Radiologic Examinations and Routine Laboratory Procedures..... 758
- BOUCOT, KATHARINE R., AND COOPER, DAVID A. Critical Evaluation of Mass Roentgen Surveys..... 759
- CLARK, DUMONT, ET AL. Diagnosis of Pulmonary Lesions Discovered by Mass Roentgenographic Survey..... 759
- HALL, STEPHEN, AND TATTERSALL, WILLIAM. Technique of Diagnostic Chest Fluoroscopy. 759
- ROBERTS, JOHN C., AND BLAIR, L. G. Bronchiectasis in Primary Tuberculous Lesions Associated with Segmental Collapse..... 759
- TEMPLE, A. D., AND CRUTCHLOW, E. F. Pulmonary Tuberculosis in the Older Age Groups.. 760
- LEMOINE, J.-M. Extremely Retracted Lobar Opacities..... 760
- ABRAMSON, HAROLD, ET AL. Acute Pulmonary Interstitial and Mediastinal Emphysema (Airblock) and Pneumothorax in Infancy and Early Childhood..... 760
- CHURCH, R. E., AND ELLIS, A. R. P. Cystic Pulmonary Fibrosis in Generalised Scleroderma... 760
- CHESNER, CHARLES. Chronic Pulmonary Granulomatosis in Residents of a Community Near a Beryllium Plant. Three Autopsied Cases. 760
- HODGSON, CORRIN H., ET AL. Pulmonary Histoplasmosis: Review of Published Cases and Report of an Unusual Case..... 761
- RUTLEDGE, L. H. An Unusual Type of Pulmonary Disease Involving Six Members of a Family..... 761
- NASH, FRANCIS P., AND SMOLIK, EDMUND A. Diffuse Pulmonary Infiltration Accompanying Eosinophilic Granuloma..... 761
- KEIL, PHILIP G., AND SCHISSEL, DONALD J. Differential Diagnosis of Unresolved Pneumonia and Bronchiogenic Carcinoma by Pulmonary Angiography..... 762
- BANYAT, ANDREW L. Metastatic Tumors of the Lung..... 762
- MINOR, GEORGE R. A Clinical and Radiological Study of Metastatic Pulmonary Neoplasms 762
- CONKLIN, WILLIAM S. Tumors and Cysts of the Mediastinum..... 763
- WILLIAMS, M. HENRY, JR. Pleural Effusion Produced by Abdomino-Pleural Communication in a Patient with Laennec's Cirrhosis of the Liver and Ascites..... 763
- SMEDAL, MAGNUS I., AND LIPPINCOTT, SAMUEL W. Extrapleural Fluid Complicating Thoracic and Thoracolumbar Sympathectomy..... 764
- DISSMAN, ERWIN. Case of Intrathoracic Lipoma in the Dome of the Pleura..... 764
- KEITH, JOHN D., AND MUNN, JOHN D. Angiocardiography in Infants and Children. New Technic..... 764
- AXÉN, O., AND LIND, JOHN. Table for Routine Angiocardiography. Synchronous Serial Roentgenography in Two Planes at Right Angles..... 764
- ABRAMSON, HAROLD. Transposition of the Great Vessels. Diagnostic Use of Angiocardiography in a Newborn Infant..... 764
- MULLER, WILLIAM H., JR., AND SLOAN, ROBERT H. Experiences with the Use of Direct Aortography in the Diagnosis of Coarctation of the Aorta..... 765
- JACKSON, HARRIS. Case of Turner's Syndrome with Coarctation of the Aorta and a Pulmonary Arteriovenous Aneurysm..... 765
- OLIVA, LUIGI. High Right-sided Aorta: A Three Dimensional Laminographic Study..... 765
- ENGLE, MARY ALLEN, ET AL. Ebstein's Anomaly of the Tricuspid Valve..... 766
- HEALEY, R. F., ET AL. Roentgenographic Appearance of Interatrial Septal Defect..... 766
- SCHMIDT, S. Pericardial Effusion with Myxedema Heart)..... 766

#### The Digestive System

- DONNELLY, BRIAN. Congenital Oesophageal Atresia with Tracheo-Oesophageal Fistula.. 766
- CIGNOLINI, M. PIETRO. Concerning the Differential Diagnosis of Esophageal Varices..... 767
- LURA, M. A. Roentgenkymographic Study of Disturbances in Motility and of Esophageal Lesions in Scleroderma..... 767
- BELLO, C. T., ET AL. Achalasia (Cardiospasm) . 767
- CARP, LOUIS. Foreign Bodies in the Gastrointestinal Tracts of Psychotic Patients..... 767

- FLOOD, CHARLES A. Benign Disease of the Antral Portion of the Stomach..... 768
- JAHIEL, RICHARD, AND FELDMAN, DANIEL J. Chronic Intermittent Benign Dilatation of the Stomach..... 768
- BERGER, D. Carcinoma of the Cardiac Portion of the Stomach..... 768
- MARSHALL, SAMUEL F., AND MEISSNER, WILLIAM A. Sarcoma of the Stomach..... 769
- PALMER, EDDY D. Sarcomas of the Stomach: A Review with Reference to Gross Pathology and Gastroscopic Manifestations..... 769
- PERKEL, LOUIS L., AND MACCHIA, BENJAMIN J. Reticulum Cell Sarcoma of the Stomach. Report of a Case in a Young Woman..... 769
- MARSHALL, SAMUEL F., AND BROWN, LOWELL. Primary Malignant Lymphoid Tumors of the Stomach..... 769
- GREENWOOD, FRANK, AND SAMUEL, ERIC. Leiomyomata of the Stomach..... 770
- BÖCK, KARL. Neurofibromatosis of the Stomach..... 770
- RUDNER, HENRY G. Prolapse of the Gastric Mucosa. Report of 22 Cases..... 770
- SHEEHAN, VINCENT, AND KELLY, COLM. Duodenum Inversum..... 770
- GREENLER, JOHN J., AND CURTIS, CHARLES N. Duodenal Diverticula..... 771
- KAUVAR, A. J., AND LEITER, LABAN W. Achlorhydria and Duodenal Ulcer..... 771
- HEYMANN, J. A., AND CLARK, GORDON G. Leiomyosarcoma of the Duodenum..... 772
- EDWARDS, EDWIN W., AND MCHARDY, GORDON. Polyp of the First Portion of the Duodenum..... 772
- OGILVIE, HENEAGE. Non-Malignant Duodenocolic Fistula..... 772
- FERRER, JOSÉ M., JR. Intussusception in Children and Adults. Critical Review with Addition of Thirty-eight New Cases..... 772
- WATSON, T. RICHARD, JR., AND CRANDELL, WALTER B. Acute Jejuno gastric Intussusception..... 773
- HAGGSTROM, GUSTAVE A., AND ROUSSELOT, LOUIS M. Acute Intestinal Obstruction..... 773
- MICHEL, MARSHALL L., JR., ET AL. Acute Intestinal Obstruction. Comparative Studies of Small Intestinal and Colic Obstruction..... 773
- HUNT, CLAUDE J. Early Manifestations and Radiologic Indications of Small Bowel Obstructions..... 774
- GROVE, LON, AND RASMUSSEN, EARL. Congenital Atresia of the Small Intestine..... 774
- CAMPBELL, DARRELL A., AND SMITH, R. GLENN. Diagnosis and Treatment of Volvulus of the Sigmoid Colon..... 774
- LEE, C. MARSHALL, JR., AND MACMILLAN, BRUCE G. Rupture of the Bowel in the Newborn Infant, Including a Case Report of Rupture in the Large Intestine with Recovery..... 774
- GROLLMAN, AARON I., ET AL. Localized Paralytic Ileus: An Early Roentgen Sign in Acute Pancreatitis..... 775
- SAMUEL, ERIC. Pancreatic Abscess. Its Radiological Features..... 775
- BAKER, JOEL W., AND WILHELM, MORTON C. Annular Pancreas: Report of a Surgical Case with a Two Year Followup..... 775
- LEVENE, GEORGE, AND PERKINS, CHARLES B. Value of Laminography in the Difficult Gallbladder Problem..... 776
- HICKEN, N. FREDERICK, ET AL. Technic, Indications and Value of Postoperative Cholangiography..... 776
- CARTER, R. FRANKLIN, AND GILLETTE, LEE. Immediate Cholangiography..... 776
- BERMAN, V., AND SKAPINKER, J. J. Case of Radio-Opaque Bile without Cholecystography..... 777
- Retroperitoneal Tumors**
- NEWMAN, HARRY R., AND PINCK, BERNARD D. Primary Retroperitoneal Tumors..... 777
- Hernia**
- ROLLANDI, ARISTIDE. Anterior Diaphragmatic Hernia..... 777
- BRICK, IRVING B., AND AMORY, HAROLD I. Incidence of Hiatus Hernia in Patients Without Symptoms..... 778
- The Musculoskeletal System**
- CHRISTIE, AMOS, ET AL. Estimation of Fetal Maturity by Roentgen Studies of Osseous Development..... 778
- COCCHI, UMBERTO. Genetic Chart in Marble Bone Disease with Dominant Polyphane Heredity..... 778
- JACOBSON, W. E. Pseudocystic Disease of Bone..... 779
- GVOZDANOVIC, VLADIMIR. New Case of Engelmann's Disease. Contribution to the Knowledge of Congenital Osteodystrophy..... 779
- BERREY, BEDFORD H. Postinfantile Cortical Hyperostosis with Subdural Hematoma..... 779
- FREEMAN, JOSEPH T. Ehlers-Danlos Syndrome..... 780
- JOHANSON, CARL-ERIK. Result of Myelographies with Water Soluble Media..... 780
- KESSEL, A. W. LIPMANN. Arthrography of the Shoulder Joint..... 780
- WITT, C. M. Supracondyloid Process of the Humerus..... 780
- WOLF, J. Larsen-Johansson Disease of the Patella..... 780
- LAUGE-HANSEN, N. Fractures of the Ankle. II. Combined Experimental-Surgical and Experimental-Roentgenologic Investigations.. 781
- The Spinal Cord**
- MATSON, DONALD D., ET AL. Diastematomyelia (Congenital Clefts of the Spinal Cord): Diagnosis and Surgical Treatment..... 781
- SCHREIBER, FREDERIC, AND NIELSEN, AAGE. Lumbar Spinal Extradural Cyst..... 782

**Gynecology and Obstetrics**

- STEVENSON, CHARLES S. Principal Cause of Breech Presentation in Single Term Pregnancies. . . . . 782
- WHITELAW, M. JAMES, ET AL. Puerperal Involution of the Urinary Tract. . . . . 783
- LUBIN, SAMUEL, ET AL. Genitourinary Changes Following Gynecologic Surgery. . . . . 783

**The Genito-Urinary System**

- FAINSINGER, M. H. Excretory Urography in the Young Subject. Hyaluronidase and Tomography as Aids. . . . . 783
- GÜNTHER, G. W. Pyelographic Misinterpretation and Nephrectomy in Essential Hematuria. . . . . 783
- GÜNTHER, G. W. Morphology and Symptomatology of Renal Tumors. . . . . 784
- HAWKINS, C. F., AND SMITH, O. E. Renal Dysplasia in a Family with Multiple Hereditary Abnormalities Including Iliac Horns. . . . . 784
- HOWARTH, V. S. Renal Hydatid Disease. . . . . 784
- BALL, THOMAS L. Topographic Urethrography. Part I. . . . . 784
- BALL, THOMAS L., ET AL. Topographic Urethrography. Part II. . . . . 785
- EDLING, NILS P. G. Demonstration of the Bladder and Urethra by Means of Water Soluble Contrast Medium. . . . . 785
- WARTHIN, THOMAS A., ET AL. Clubbing of Digits, Metaplasia of Urinary Bladder and Mucous Diarrhea. . . . . 786

**The Blood Vessels**

- CAMPBELL, DARRELL A., AND SMITH R. GLENN. Arteriography in the Evaluation of Arteriosclerotic Vascular Insufficiency. . . . . 786
- KUSZ, CLARENCE V. Venography in the Postphlebotic Syndrome. . . . . 786
- GOODMAN, JOSEPH I., ET AL. A Study of Atherosclerosis in a Group of Diabetic Patients. . . . . 786
- BERNEIKE, ROBERT R., AND POLLOCK, HENRY M., JR. True Renal-Artery Aneurysm. . . . . 787

**Technic; General Considerations**

- STEVENSON, J. J. Horizontal Body Section Radiography. . . . . 787
- BELL, JOSEPH C. Radiology in the Rural Practice. . . . . 787

**RADIOTHERAPY**

- WATSON, T. A. Advances in Radiotherapy. . . . . 788
- ELLIS, FRANK, ET AL. Discussion on the Chemical Factors Modifying Radiotherapeutic Response. . . . . 788
- BUSCHKE, FRANZ. Radiotherapy of Pituitary Adenomas. . . . . 789
- SHARP, GEORGE S., ET AL. Radiation versus Surgery for Cancer of the Tongue. . . . . 790
- CUTLER, MAX. Radiotherapy of Early Cancer of the Larynx. Five Year Results in One Hundred and Fifty-Six Cases. . . . . 790

- VOIGT, K. Irritative Cough Due to Neck Metastases. . . . . 790
- CHIKIAMCO, PATERNO S., AND CHIKIAMCO, CARMEN S. Role of Radiology in the Diagnosis and Treatment of Mediastinal Tumors. . . . . 791
- LUMB, GEORGE. Changes in Carcinoma of the Breast Following Irradiation. . . . . 791
- KIMBROUGH, ROBERT A., AND MUCKLE, CRAIG W. Carcinoma of the Endometrium. . . . . 791
- JOHNSON, W. O., AND WEINFURTER, B. J. Carcinoma of the Cervix Associated with Pregnancy. . . . . 792
- FRIEDEL, H. L., ET AL. Beta-Ray Application to the Eye, with the Description of an Applicator Utilizing Sr<sup>90</sup> and Its Clinical Use. . . . . 792
- WILSON, FRED M. Beta Irradiation. An Evaluation of a Radium-D Applicator for Ophthalmic Use. . . . . 792
- LAVAL, JOSEPH. Glioma of the Retina in Father and Child. . . . . 793
- LEVER, WALTER F., AND LEEFER, ROY W. Eosinophilic Granuloma of the Skin. Report of Cases Representing the Two Different Diseases Described as Eosinophilic Granuloma. . . . . 793

**RADIOISOTOPES**

- CARPENDER, J. W. J. Significance of Radioisotopes to Radiology. . . . . 793
- NEWELL, R. R. What's New in Isotopes, 1950. . . . . 794
- JAFFE, HENRY L., AND OTTOMAN, RICHARD E. Evaluation of Radioiodine Test for Thyroid Function. . . . . 794
- WEINBERG, S. J., ET AL. Metastatic Adenocarcinoma of the Thyroid with Elevated Basal Metabolism: Radioiodine Studies. . . . . 794
- McCULLAGH, E. P., ET AL. Radioactive Iodine Uptake in the Hypermetabolism of Acromegaly. . . . . 795
- LAWRENCE, JOHN H., AND WASSERMAN, LOUIS R. Multiple Myeloma: A Study of 24 Patients Treated with Radioactive Isotopes (P<sup>32</sup> and Sr<sup>90</sup>). . . . . 795
- PATTON, HENRY S., AND MILLAR, R. GORDON. Accidental Skin Ulcerations from Radioisotopes. Recognition, Prevention and Treatment. . . . . 795
- McKEE, FRANK W., AND STEWART, WELLINGTON B. Passage of Radioactive Erythrocytes from the Peritoneal Cavity into the Blood Stream During Experimental Ascites. . . . . 796
- WARD, THOMAS G. Use of Radioactive Phosphorus in Studies of Chick Embryo Infections with a Common Cold Virus. . . . . 796
- GRAHAM, A. F. An Apparatus for Pipetting Radioactive Solutions. . . . . 796

**EFFECTS OF RADIATION**

- LEAR, HAROLD, AND OPPENHEIMER, GORDON D. Anuria Following Radiation Therapy in Leukemia. . . . . 796

- NEUMANN, CHARLES G. Acute Thermal, Chemical, Electrical and Radiation Injuries..... 796
- SMITH, LESLIE M., AND GARRETT, H. D. Resin of Podophyllum in Treatment of Cancerous and Precancerous Conditions of Skin. Effect on Basal Cell Epithelioma and Seborrheic, Senile and Radiation Keratoses..... 796
- VAN ALLEN, WILLARD W. Protecting Photo-fluorographic Personnel from Excessive Radiation..... 797
- HUFF, R. L., ET AL. Tracer Iron Distribution Studies in Irradiated Rats with Lead-Shielded Spleens..... 797
- DOUGLAS, D. M., ET AL. Atrophy of the Gastric Glands Produced by Beta Rays. Histologic Findings in Animals..... 797
- SCHEIE, HAROLD G., ET AL. Effect of Low-Voltage Roentgen Rays on the Normal and Vascularized Cornea of the Rabbit. Preliminary Report on the Philips Machine..... 797
- CRAWFORD, J. N. B. Medical Aspects of the Effects of Atomic Explosion..... 798





## ROENTGEN DIAGNOSIS

### THE HEAD AND NECK

**Cerebral Angiography.** Jean-Louis Leger. J. Canad. A. Radiologists 1: 25-28, June 1950. (In French)

Cerebral angiography assumes more and more importance in neurology, as testified by the awarding of the 1949 Nobel Prize for Medicine to Egas Moniz, whose first studies were reported in 1927. Diodrast in 35 per cent solution appears to be the safest preparation, although Broman and Olsson (Acta radiol. 31: 321, 1949. Abst. in Radiology 54: 767, 1950) have shown that it increases vascular permeability and may lead to cerebral edema.

Angiography aids in the diagnosis and location of arterial aneurysms and arteriovenous fistulas. Bilateral studies are indicated to detect possible multiple aneurysms. Expansive tumors are localized by the angiographic demonstration of vascular displacements as well as by ventricular displacements shown on the pneumogram. Occasionally the two types of study are complementary. Subdural hematoma may be diagnosed with certainty by angiography. The anteroposterior view shows a displacement of the cortical vessels away from the inner table of the skull and a concave lacunar image.

In the study of posterior fossa tumors, ventriculography is superior to angiography. Certain prefrontal tumors, also, are not well demonstrated by vascular displacement, due to the relative immobility of the pericallosal and callosomarginal arteries. Expansive temporal or subsylvian lesions, on the other hand, are well shown angiographically.

Some tumors exhibit intrinsic vascular patterns that are characteristic. Meningiomas often have a double arterial supply from the internal and external carotid systems and present a homogeneous density in the stage of venous filling. Metastases are often multiple. Glioblastoma multiforme presents new formation of "corkscrew" blood vessels and arteriovenous shunts.

Five roentgenograms. CHARLES NICE, M.D.  
University of Minnesota

**Gliomas Involving the Splenium of the Corpus Callosum. A Roentgenologic Study.** Benno Schlesinger. J. Neurosurg. 7: 357-363, July 1950.

Gliomas of the splenium, like other gliomas of the corpus callosum, originate in the region of the superomedial angle of the lateral ventricle. The growth spreads by infiltration of the forceps posterior on either side. Extension into the adjacent calcar avis is a frequent occurrence and the entire medial wall of both the atrium and posterior horn is infiltrated. The cavity of the ventricle in the involved region, therefore, is narrowed and there is abnormal separation of the posterior portions of both lateral ventricles. If the lesion extends forward toward the mid portion of the corpus callosum, the inward and downward slant of the roof of the descending portion of the lateral ventricle appears to be greatly increased. There is a downward and forward displacement of the pineal gland.

While it appears that the lesions under consideration can be more readily diagnosed by air studies than by clinical methods, the roentgen examination does not necessarily tell the whole story. Irregular spread into

the caudate nucleus and thalamus may escape detection.

Three cases of gliomas involving the splenium of the corpus callosum are presented.

Four roentgenograms; 2 photographs.

HOWARD L. STEINBACH, M.D.  
University of California

**Myotonic Dystrophy and Cranial Hyperostosis.** Michel Jéquier. Schweiz. med. Wchnschr. 80: 593-599, June 10, 1950. (In French)

Radiographic study in six subjects belonging to two generations of a family, of which three had myotonic dystrophy, revealed consistent anomalies in the form of diffuse hyperostosis of the skull. The changes were predominantly frontal, temporo-occipital, and basal. The observations confirm the work of several authors. In the younger subjects (seventeen to thirty-nine years) of this stock, and in another case, apparently non-familial, the anomalies are more discrete, of the type of hyperostosis frontalis interna, and permit a glimpse of various stages of the development of the hyperostoses.

Certain possibilities concerning the familial relationship of myotonic dystrophy and cranial hyperostoses are discussed. One possibility is that both are the result of a central diencephalic neuro-endocrine disturbance which is based on a genetic disorder. The second possibility is that the neuromuscular and osseous findings are two pleiotropic manifestations of the same gene. The third possibility is that two different genes are associated by chance in certain stocks. The first possibility seems most likely.

Fifteen roentgenograms; 5 photographs.

CHARLES NICE, M.D.  
University of Minnesota

**Craniofacial Dysostosis (Crouzon's Disease). Report of Three Cases.** Max S. Lake and John C. Kuppinger. Arch. Ophth. 44: 37-46, July 1950.

Craniofacial dysostosis, a rare deformity produced by premature synostosis of certain craniofacial sutures, characteristically shows frontal bosses, prognathism, exophthalmos, exotropia, optic nerve atrophy, and maxillary hypoplasia. The roentgen picture is characterized by (1) absence of the suture lines in the fully developed cases, (2) digital impressions on the inner table of the skull from pressure convolutions of the brain, (3) depression of the middle fossa, and (4) small paranasal sinuses.

Three cases of familial occurrence are presented, and a preliminary report is given on a patient in whom surgical correction was made in early childhood. These cases give proof of the hereditary nature of the condition.

Six roentgenograms; 4 photographs; 1 chart.

**Reconstruction of the Floor of the Orbit by Bone Grafts.** John Marquis Converse and Byron Smith. Arch. Ophth. 44: 1-21, July 1950.

The orbital contour may be distorted by comminution of bone and telescoping of fragments in maxillary and zygomatic fractures, congenital malformations, loss of bone from osteomyelitis, radiation necrosis, and destructive surgical procedures for the eradication of malignant growths. Deformity, orbital disturbances and

diplopia result. Clinical and roentgenologic methods of evaluation of such orbital deformities are discussed. The roentgen examination (Pfeiffer: *Tr. Am. Ophth. Soc.* 39: 492, 1941) employs five projections: the Caldwell view, the Waters view, the lateral view, the view of the optic canals, and the basal view.

The Caldwell view, taken in the nose-forehead position, defines the frontal projection of the orbits and superimposes the outline of the petrous portions of the temporal bones on the superior maxillas. The orbital margins, superior orbital fissures, sphenoidal ridges, and lines of the temporal fossae are visualized in the roentgenogram. The frontal and ethmoidal sinuses and the nasal fossae are also clearly defined.

The Waters view, taken in the nose-chin position, projects the superior maxilla without superimposition of the petrous bones. In such a view the maxillary sinuses are clearly defined. The orbits, shown above the maxillary sinuses, are distorted, owing to the inclined position. The orbital boundaries are clearly indicated, as are the zygomatic bones and the arches.

The lateral view is advantageous for the proper interpretation of anterior and posterior relations.

Clearly defined views of the optic canals can be obtained only by their projection.

Technical difficulties in obtaining the basal view require the elevation of the patient's body above the level of the x-ray table to compensate for the limited extensibility of the cervical portion of the spine. The basal view is used primarily to obtain details of the middle cranial fossa, the sella turcica, and the comparative symmetry of the orbits and fossae.

Stereoscopic roentgenograms of both orbits, properly centered for comparison, are an adjunct in detailed analysis. Proper positioning to obtain symmetric projection is necessary for correct exposure and interpretation.

The technic of reconstruction of the floor of the orbit by autografts and homografts of bone is described in 14 cases in which it was successful.

Egihl figures, including 1 roentgenogram.

### THE CHEST

**A Simple, Safe Bronchographic Technique for Children.** Joseph B. Miller, William H. Conyers, Jr., and Norman Dinhoff. *J. Pediat.* 36: 721-727, June 1950.

Bronchography is performed less frequently than is desirable because of the technical difficulties for the operator and the discomfort and danger to the patient. In children, both of these factors are greatly magnified. In an attempt to simplify the procedure and decrease its difficulties in children, a new technic has been evolved which is advantageous for adults as well. It is based primarily on nebulization of the surface anesthetic as described in previous reports (Miller, Mann, and Abramson: *Dis. of Chest* 16: 408, 1949). The time for anesthetization has now been shortened to twenty minutes. The anesthesia has been improved by adding to the anesthetic solution a detergent (Triton A-20), for its spreading and penetrating properties, and a droplet stabilizer (glycerin) to inhibit evaporation of the small droplets before they are deposited in the respiratory passage. Epinephrine is added for its vasoconstricting effect to delay absorption of the anesthetic drug (0.5 per cent pontocaine). The rate of oxygen flow originally used was 6 liters per minute; this has

been increased to 10 to 12 liters per minute once the preliminary anesthetization of the pharynx has been obtained.

The advantages of this method are lack of discomfort to the patient, simplicity, and relative safety. Another desirable feature is the rapid elimination of lipiodol from the tracheobronchial tree by prompt drainage. This tends to prevent side-reactions from the iodized oil itself, removes a major objection to bronchography in the presence of tuberculosis, and keeps the lung fields from being obscured for months by alveolar deposition.

Nine illustrations.

**Ioduron B: A Water Soluble Contrast Medium for Bronchography: Preliminary Report.** Norman M. Brown. *J. Canad. A. Radiologists* 1: 29-32, June 1950.

The disadvantages of the use of iodized oil as a contrast medium for bronchography are well known. Remnants of oil persist in the lungs for months or even years, thereby interfering with subsequent diagnostic procedures. There is some evidence to suggest that the oil acts as an irritant, causing damage to body tissues. It does not mix with body secretions and therefore does not spread out on surfaces in a thin layer but remains in droplets. This may lead to diagnostic errors.

Since 1931, many attempts have been made to develop a water-soluble contrast medium which would have the advantage of rapid elimination by the body. The drug Ioduron B (a 30 per cent aqueous solution of morphaline salt of pyridone di-iodide compound containing 55 per cent iodine) is the subject of the present report. The author's experience with this drug has been limited to bronchography in 4 patients. One of these patients was examined twice within a three-day period, for a total of 5 bronchograms. Each examination was unilateral.

Ioduron B is rapidly eliminated from the body, and this constitutes its outstanding advantage. Elimination is by the kidneys, a contrast-filled bladder being observed twenty to thirty minutes after visualization of the bronchial tree. All of the contrast medium has usually disappeared from the lungs three to four hours after bronchography. No residue has been observed in the lungs after twelve hours. For demonstration of fistulas and cavities dilution of the medium with normal saline is recommended.

The technic of examination with Ioduron B is described. It differs from that used with iodized oil in one respect, namely, that much more time and effort are expended in preliminary anesthesia.

The drug has the disadvantage of being irritating to the bronchi, thereby causing coughing. Attempts are being made to overcome this by more prolonged and painstaking preliminary anesthesia. Slight hemoptysis has also been encountered. This is to be investigated by animal experiments.

Six roentgenograms.

**Detection of Pulmonary Tuberculosis. Comparative Value of Routine Radiologic Examinations and Routine Laboratory Procedures.** Homer D. Peabody, Jr., and R. H. Sundberg. *California Med.* 72: 450-453, June 1950.

Some type of radiologic chest study is recommended as part of the routine procedure for complete patient evaluation regardless of symptoms and signs. In a

series of 951 patients for whom stereoscopic  $4 \times 5$ -inch photoroentgenograms were obtained as part of a general examination, the authors found significant or suspicious abnormalities in 148 or 15.6 per cent. Although few patients with specific chest complaints were included in the study, significant pulmonary disease was discovered in 21 cases (minimal active tuberculosis in 7, pulmonary fibrosis in 6, emphysema in 4, and abnormally increased markings in 4).

The authors compare the results of the photoroentgen studies with those of other routine procedures in the same group of patients, showing that practically as many (or more) abnormalities were demonstrated photoroentgenographically as by laboratory procedures which are usually considered essential, namely hemoglobin and blood sedimentation rate determinations and urinalysis. The number of cases of clinically important pulmonary tuberculosis uncovered as a result of further study of chest abnormalities was comparable to the number in which disease was revealed by the more specific serologic examination for syphilis.

Procedures	Abnormal Findings
Photoroentgen chest examination	148 (15.6%)
Serologic test for syphilis	8 (0.8%)
Sedimentation rate	159 (16.8%)
Hemoglobin determination	70 (7.4%)
Urinalysis	124 (13.1%)

Seven tables.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**A Critical Evaluation of Mass Roentgen Surveys.** Katharine R. Boucot and David A. Cooper. *J. A. M. A.* 142: 1255-1257, April 22, 1950.

Mass chest surveys can aid in controlling tuberculosis and in uncovering pulmonary neoplasms. Although there is a lack of adequate bed space to care for patients with active tuberculosis, the extent of the problem should be known, and many patients who find that they have positive sputum are willing and ready to protect their contacts and to limit their own regimen for the betterment of their health.

In order to achieve the goal of screening out significant pulmonary disease, the photofluorograms should be over-read and the essential prompt follow-up of suspected abnormality done by an adequate trained physician.

If bronchial carcinoma is to be cured, it must be suspected earlier and handled as a medical emergency. Persistent pulmonary lesions not proved to be tuberculosis should be considered potentially malignant, especially in men past middle age.

The percentage of abnormality demonstrated by a survey varies with the nature of the group. It also should be recognized that innumerable persons with pulmonary symptoms come to survey units for photofluorograms. Questioning by the technician can frequently increase the value of such photofluorograms. A negative report in a patient with symptoms can be misleading.

Annual roentgenograms of the chest of all adults is a feasible goal, and to find curable bronchial neoplasm, men over 45 should be surveyed every six months.

Six roentgenograms.

HOWARD B. LATOURETTE, M.D.  
University of Michigan

**Diagnosis of Pulmonary Lesions Discovered by Mass Roentgenographic Survey.** Dumont Clark, Carl W. Tempel, and Kenneth D. A. Allen. *J. A. M. A.* 143: 943-951, July 15, 1950.

This paper defies abstracting since it is itself essentially an outline, first, of diagnostic procedures for the identification of lesions discovered on the small survey film; second, of the differential diagnosis of the more important lesions which may be demonstrated.

Among 1,577 patients with an initial diagnosis of pulmonary tuberculosis examined at Fitzsimons General Hospital, Denver, Colo., 38 were found to have no pulmonary disease while in 154 some other condition was present as follows:

Fibrosis and emphysema (including chronic bronchitis and asthma).....	47
Bronchiectasis.....	16
Bullous emphysema, cystic disease, spontaneous pneumothorax.....	15
Fungus infections.....	11
Chronic non-specific pneumonitis and atelectasis.....	9
Acute infectious bronchitis, lung abscess, pneumonia.....	9
Silicosis.....	8
Chronic lung abscess and chronic encapsulated empyema.....	8
Atypical pneumonia.....	5
Circulatory changes (chronic passive congestion).....	5
Bronchogenic carcinoma.....	4
Sarcoidosis.....	4
Leukemia, polycythemia, collagen diseases, eosinophilic pneumonopathy (Loeffler's syndrome).....	4
Lesions of the thoracic cage.....	3
Metastatic carcinoma.....	2
Diaphragmatic hernia.....	2
Lymphoma.....	1
Arteriovenous aneurysm.....	1

Ten roentgenograms. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Technique of Diagnostic Chest Fluoroscopy.** Stephen Hall and William Tattersall. *Lancet* 1: 490-492, March 18, 1950.

The authors, who are chest physicians, describe the technic for fluoroscopic examination in the diagnosis of chest conditions. They believe that screening alone can safely be used to exclude tuberculous lesions, thus saving many films which are at present wasted. This would also relieve congestion in x-ray departments and save money and time.

An editorial in the same issue calls attention to the drawbacks of fluoroscopy and suggests that, if it is to be widely used, a method for testing the accuracy of the observer is needed.

**Bronchiectasis in Primary Tuberculous Lesions Associated with Segmental Collapse.** John C. Roberts and L. G. Blair. *Lancet* 1: 386-388, March 4, 1950.

The incidence of pulmonary collapse and the incidence and etiology of bronchiectasis were investigated in 421 children who were in-patients at the Harefield Hospital (England) during the war years. There were 400 cases of primary lung lesions, of which 77 (19 per

cent) showed collapse of a segment, of a lobe, or a lung. Bronchography revealed bronchiectasis in 34 of the 37 cases in which the examination was performed. Twelve cases showed obvious bronchiectasis on plain roentgenograms, bringing the total to 46 (60 per cent). Careful clinical and roentgenologic study failed to disclose any evidence of bronchiectasis in 31 cases of pulmonary collapse.

The authors conclude that involvement of the bronchi by a tuberculous lesion, whether through extrinsic pressure from a node, edema of the bronchial mucosa, or infiltration of the bronchial wall, may lead to distention beyond the obstruction by retained mucus, tuberculous caseous material, or by secondary infection of the retained mucus. This distention is an important factor in producing bronchiectasis. Symptoms commonly arise when secondary infection supervenes.

Increased negative intrapleural pressure causing a pull on the bronchi in localized pulmonary collapse where the pleura is free seems to be of negligible significance in the causation of bronchiectasis.

In children with pulmonary collapse a Mantoux test should be done and, if it is positive, possible sources of tuberculous infection should be sought.

Bronchoscopy, combined with suction and postural drainage, is advised both for prophylaxis and treatment, and should be undertaken immediately if there is evidence of secondary infection beyond the block.

If operation is indicated for bronchiectasis in a child, a tuberculous etiology should always be considered. If it is found, at least two years should be allowed for healing before operation is undertaken, and streptomycin should be used to cover the operation.

In view of the role of secondary infections in producing symptoms and irreversible changes in the bronchi and lung, these infections should be treated energetically. Particular attention should be paid to the upper respiratory tract as a potent source of infection of the collapsed area.

Sixteen roentgenograms.

**Pulmonary Tuberculosis in the Older Age Groups.** A. D. Temple and E. F. Crutchlow. *Canad. M. A. J.* 62: 565-568, June 1950.

In spite of the emphasis upon tuberculosis case finding through surveys and routine hospital admission x-ray programs, persons under the age of ten and over the age of fifty years have been excluded from many of the case-finding programs.

In a study of patients at the St. Hyacinthe Veterans' Hospital (Quebec), a tuberculosis sanitarium of 200 beds, 39 patients in a total of 175, *i.e.*, 22 per cent, were found to be over fifty years of age; 31 patients, (19 per cent of the total) had active, sputum-positive tuberculosis which was discovered after the age of fifty. Only a few presented chest symptoms which led to the diagnosis. In the majority the disease was discovered on routine x-ray examination. The average age at the time of diagnosis was 57.6 years.

One table.

ROBERT H. LEAMING, M.D.  
Jefferson Medical College

**Extremely Retracted Lobar Opacities.** J.-M. Le-moine. *J. franç. de méd. et chir. thorac.* 4: 544-546, 1950. (In French)

At times the opacity of the extremely contracted right middle lobe is scarcely noticeable on the routine postero-

anterior chest roentgenogram. Two important signs to be noted are invisibility of the basic portion of the right pulmonary artery and a wider separation of the branches of the right pulmonary artery than is usually seen. These two signs should lead to suspicion of atelectasis of the right middle lobe with extreme retraction. Further radiologic and clinical studies are then indicated.

Four roentgenograms.

CHARLES NICE, M.D.  
University of Minnesota

**Acute Pulmonary Interstitial and Mediastinal Emphysema (Airblock) and Pneumothorax in Infancy and Early Childhood.** Harold Abramson, George D. Rook, and Cornelius H. Nau. *J. Pediat.* 36: 774-783, June 1950.

In the differential diagnosis of unexplained acute respiratory and circulatory embarrassment in infancy with dyspnea and cyanosis as the predominant signs, the occurrence of pulmonary interstitial and mediastinal emphysema and of spontaneous pneumothorax should be borne in mind. History and physical signs do not always reveal the underlying condition. The cyanosis and dyspnea may at first be erroneously ascribed to disease of the respiratory tract or to disorder of the heart. Collateral roentgenographic studies will, however, prove of value in the early detection of extraneous collections of air in the mediastinal areas and in the pleural spaces.

Five cases, demonstrating some representative causes of airblock, are reported.

Seven roentgenograms.

**Cystic Pulmonary Fibrosis in Generalised Scleroderma. Report of Two Cases.** R. E. Church and A. R. P. Ellis. *Lancet* 1: 392-394, March 4, 1950.

Cystic changes in the lung are an unusual finding in scleroderma. Clinically the changes produced are similar to those described in "honeycomb lung," and it is assumed that the mechanism of cyst production is similar. Progressive fibrosis leads to bronchiolar obstruction. Areas of obstructive emphysema result from this, and ultimately, when the obstruction becomes almost complete, cysts are formed. The process of cyst formation, once begun, may be accelerated by fibrotic contraction of the surrounding tissues.

The authors review the literature on scleroderma with fibrosis of the lungs and report 2 cases with pulmonary fibrosis and cyst formation. Both cases have been under observation for many years. In one patient the lung changes became manifest with certainty less than seven years from the onset of the disease. The lung condition in the second case has been observed developing during the last three years, ten years from the onset of the symptoms of scleroderma.

Scleroderma should be considered in the differential diagnosis of obscure fibrotic lung conditions, and it should be remembered that the lung lesions may occur without obvious skin changes.

Three roentgenograms.

**Chronic Pulmonary Granulomatosis in Residents of a Community Near a Beryllium Plant: Three Autopsied Cases.** Charles Chesner. *Ann. Int. Med.* 32: 1028-1048, June 1950.

The purpose of this paper is to alert physicians to a chronic type of pulmonary disease of high fatality oc-



currence among individuals living in a community where beryllium is produced (Lorain, Ohio).

Eleven cases of delayed chemical chronic pneumonitis were observed in this area, including 7 in persons who did not work with beryllium or its compounds. Four of these 7 patients lived within less than a quarter of a mile (300 meters) from the beryllium plant for a period of one to four years. There was one death in this group. Two lived about half a mile from the plant for periods of one to five years, and both died.

The low incidence, spotty distribution, and lack of relationship of the severity of the disease to the degree of exposure were in accord with other reports.

Studies of the sputum by smear or culture for a predominating bacterium, or fungus, and for tubercle bacilli were uniformly negative. The author was unable to produce the disease in animals by injection or inhalation of zinc beryllium silicate, beryllium oxide, or other mixed phosphors recovered from old incandescent lamps.

Chest roentgenograms were characteristic in all cases and helped clinch a doubtful diagnosis. Three stages are defined: (1) a fine diffuse uniform granularity, like sandpaper, with normal hilar markings; (2) a diffuse reticular pattern on the granular background with fuzzy hilar shadows; (3) distinct nodules, from 1 to 5 mm. in diameter, resembling a snow storm, evenly distributed, fuzzy hilar shadows, and prominence of the pulmonary artery.

The basic lesion was a diffuse intra-alveolar nodular granulomatosis which involved all lung fields at an early stage. The nodules were composed of a preponderance of large endothelial-like cells, with intermingled plasma cells, mononuclears, and lymphocytes. No caseation was found at any stage. Giant cells of both the foreign body and Langhans types were noted in fairly large numbers in all cases. The focal lesions remained prominent. Other constant findings were right cardiac dilatation and hypertrophy, chronic passive congestion, and compensatory pulmonary emphysema.

The clinical diagnosis is based upon an occupational history of exposure to beryllium or residence in a community where beryllium is produced, plus a typical clinical picture of insidious onset, with cough and exertional dyspnea. The symptoms progress in spite of changes of environment. The course is usually afebrile. Cachexia and weight loss may be prominent.

In the differential diagnosis, Boeck's sarcoid, miliary tuberculosis, silicotuberculosis, pneumoconiosis, fungous infections, miliary carcinomatosis, and other forms of chemical pneumonitis are to be considered.

No effective treatment is known. Residence in a dry and warm climate is conducive to clinical improvement. The prognosis is one of chronicity and high mortality.

No minimal level for beryllium need be present in the tissues in order to make a diagnosis of pulmonary granulomatosis in beryllium workers. No recognized relationship between the amount of beryllium found in the tissues at autopsy and the pathologic state is demonstrable.

The public health aspect of the situation is obvious. Fumes and dusts from a beryllium plant should be disposed of properly and not be permitted to pollute the air.

Seven photomicrographs; 1 table.

STEPHEN N. TAGER, M.D.  
Urbana, Ill.

**Pulmonary Histoplasmosis: Review of Published Cases and Report of an Unusual Case.** Corrin H. Hodgson, Lyle A. Weed, and O. Theron Clagett. *J. Thoracic Surg.* 20: 97-104, July 1950.

Up to 1949 the literature contained reports of 123 cases of histoplasmosis, only 62 of which had proved pulmonary involvement. Chest films were obtained in 45 of the 62 cases and in 8 instances were reported negative. Of the 37 with positive films, 30 showed bilateral disease. Descriptions of lesions varied and no characteristic roentgenographic pattern was realized. In only 8 cases was calcification found. Cavitation was rare. Peribronchial infiltration, extending radially from the hilar region, such as one may associate with fungous disease of the lung, was reported in only one-third of the cases. The authors report 1 case with successful lobectomy and mention another in an *Addendum*. Previously only one such case had been recorded.

Three illustrations, including 1 roentgenogram; 1 table.

HAROLD O. PETERSON, M.D.  
University of Minnesota

**An Unusual Type of Pulmonary Disease Involving Six Members of a Family.** L. H. Rutledge. *Minnesota Med.* 33: 694-699, July 1950.

The author describes an unusual pulmonary disease which involved an entire family of six people living together in a clean, well kept farm home. The symptoms were similar to influenza, consisting of a temperature rise of varying degree, a rasping non-productive cough, chills, and general malaise.

Roentgenograms taken on one of the patients over a period of twenty-five months tell an interesting story of initial minimal pulmonary infiltration, gradual development, pleurisy, massive involvement of both lungs, gradual clearing, and partial resolution. The first films, obtained on the second day of illness, showed an increase in the bronchovascular markings throughout both lungs, with a few tiny nodules on the right side and a few on the left side in the middle lung field. A week later there were numerous nodular densities extending from the apex to the base on both sides. On the twentieth day, there was marked coalescence of the process, with fluid in the right pleural cavity and diffuse nodular and infiltrative processes in both lungs from apex to base. Two months later, the first clearing of the pulmonary condition was demonstrable roentgenologically. From then on, improvement was gradual but steady, and after twenty-five months there was practically complete resolution of the old inflammatory process in the lung fields. Fibrosis was present in the right lower lung field, but nodularity had cleared. In the other cases, also, the period of resolution was prolonged.

Dr. Leo G. Rigler, who reviewed the films of the family, believed that they represented a pulmonary fungous infection, probably aspergillosis.

Twelve roentgenograms. DANIEL WILNER, M.D.  
Atlantic City, N. J.

**Diffuse Pulmonary Infiltration Accompanying Eosinophilic Granuloma.** Francis P. Nash and Edmund A. Smolik. *J. Missouri M. A.* 47: 414-418, June 1950.

The case reported here is that of a diffuse pulmonary infiltration with proved osseous eosinophilic granuloma, but free of any of the additional protean manifestations of generalized xanthomatous diseases.



Pain is most often the presenting symptom of eosinophilic granuloma and is usually localized to the area about the bony lesion. At times it is of insidious onset but, in the greater percentage of reported cases, it is antedated by trauma. Radiographic studies reveal ovoid osseous defects, indistinguishable from such bony lesions as multiple myeloma, metastatic tumor, osseous inflammatory processes, or osseous manifestations from some of the reticulo-endothelial disorders. In 60 per cent of cases the lesions are multiple. Hematologically, there may be a mild leukocytosis accompanied, in some cases, by a mild peripheral eosinophilia. Grossly, bony lesions show diffuse medullary involvement, with total or subtotal cortical destruction. The lesion is of a brownish-gray color, with a soft, mushy appearance, and not sharply defined at the periphery. Microscopically, the picture is one of a granulomatous lesion with eosinophilic leukocytic infiltration.

Surgical intervention is believed to be the method of choice, though radiotherapy is also beneficial in large or multiple lesions. The prognosis is excellent.

The authors' patient was a 29-year-old male who four months prior to hospital admission was struck in the left frontal area by a hard metal object. Physical and neurologic examinations were entirely negative except for marked tenderness in the left frontal area. Palpation of this region revealed a tender irregular defect in the skull about 4 cm. in diameter. Roentgenograms showed an osteolytic lesion in the left frontal bone. Routine laboratory studies were normal.

At operation, the periosteum was found to be purple-red and thickened. Attached to it was a granular material that separated from an underlying gray, putty-like mass involving the entire thickness of the bone. The entire area was curetted down to the dura, where there were a few fine dural adhesions. Microscopically, the specimen showed numerous eosinophilic leukocytes with their deeply stained nuclei and coarse granular cytoplasm in a loose edematous ground substance. Between aggregations of eosinophils were faintly outlined histiocytes.

X-ray studies revealed no additional skeletal lesions. Chest films, however, showed a diffuse progressive pulmonary infiltration. Eleven months postoperatively the chest was normal, and healing of the osteolytic lesion in the skull was demonstrable.

Seven roentgenograms; 1 photomicrograph.

HUGH A. O'NEILL, M.D.  
Cleveland, Ohio

#### Differential Diagnosis of Unresolved Pneumonia and Bronchiogenic Carcinoma by Pulmonary Angiography.

Philip G. Keil and Donald J. Schissel. *J. Thoracic Surg.* 20: 62-65, July 1950.

Radiographic differentiation between unresolved pneumonia and primary bronchial carcinoma may be aided by study of the vascular pattern of the involved lung segment. Percutaneous administration of 50 c.c. of 70 per cent diodrast into an antecubital vein gave suitable visualization for the investigation in 26 patients with bronchial carcinoma and 35 patients with unresolved pneumonia. Normal or increased vascularity was found characteristically in the pneumonias. Decreased vascularity within and distal to the carcinoma was observed in 24 of the 26 cases of cancer.

Five roentgenograms.

HAROLD O. PETERSON, M.D.  
University of Minnesota

#### Metastatic Tumors of the Lung.

Andrew L. Banyai. *Dis. of Chest* 17: 681-690, June 1950.

Metastatic tumors of the lung may exist without producing significant symptoms. When symptoms are present, they vary. There may be a persistent unproductive hacking cough, becoming productive, with a mucopurulent, purulent, or foul sputum, when bronchopneumonia, lung abscess, or bronchiectasis complicates the picture. Other symptoms are wheezing, hemorrhage, blood-streaked sputum, pain, and dyspnea. Expectorated material should be examined for food particles; these indicate fistulous communication with the esophagus. Physical examination may show distended thoracic veins and swelling of the neck, toxic effects due to the new growth, and cyanosis. X-ray examination will reveal the mass, compression of the trachea and bronchi, pleural effusions, spontaneous pneumothorax, and phrenic paralysis.

Carcinoma is responsible for most of the metastatic lung tumors. The route of spread may be direct hematogenous, indirect hematogenous via the thoracic duct, by contiguity, or through the hilar lymph nodes. Pathologically, the following forms are distinguished:

1. Large, spheroid, multiple, more or less symmetrical, bilateral, sharply delimited masses with or without associated enlargement of the hilar and mediastinal lymph nodes.
2. Miliary nodules in both lungs, with lymphangitis carcinomatosa.
3. Solitary tumor in one or both lungs.
4. Enlarged hilar and mediastinal lymph nodes, with infiltrative extension into the lung.
5. Pleural involvement.

Other tumors which metastasize to the lungs include osteogenic sarcoma, Ewing's tumor, Wilms' tumor, liposarcoma, Hodgkin's disease, chorionepithelioma, mixed tumors of the uterus, dysgerminoma of the ovary, malignant testicular tumors. Sarcoma, regardless of location, has a pronounced tendency to pulmonary metastasis through the blood stream.

Diagnosis depends upon a careful history, physical examination, and roentgen study. Multiple shadows are of five kinds:

1. Miliary nodules widely distributed throughout both lung fields. (The author includes a list of non-malignant diseases which also present miliary nodulations roentgenographically.)
2. Small snowflake-like opacities widely distributed throughout both lung fields.
3. Ill-defined shadows up to 3 cm. in diameter scattered throughout both lung fields.
4. Sharply demarcated, dense round shadows, varying from 25 to 30 mm. in diameter.
5. Massive, well defined, somewhat oval shadows, much larger than those mentioned above.

Solitary tumors in the lung field are usually well delineated, though the borders may be hazy on account of perifocal hemorrhage.

HENRY K. TAYLOR, M.D.  
New York, N. Y.

#### A Clinical and Radiologic Study of Metastatic Pulmonary Neoplasms.

George R. Minor. *J. Thoracic Surg.* 20: 34-42, July 1950.

During a five-year period, from 1937 to 1942, 314 metastatic neoplasms of the lungs were found at the

University of Michigan, in which the identity of the primary tumor was well established. During this same period, the total number of similar primary neoplasms was 5,727. Carcinoma of the breast was the commonest primary lesion producing lung metastases, although not the highest in incidence of metastases. As a rule, the presence and severity of symptoms was not related to the form or collective size of the secondary tumors.

The metastatic lesions were of five types radiologically: nodular, amorphous, lymphangitic, miliary, and massive consolidation. Many different primary carcinomas produced similar metastases. A number of the pulmonary lesions showed cavitation simulating the appearance of an abscess. More metastases were found on the right side. The largest were secondary to sarcomas.

From the standpoint of anatomic distribution in the lung, only 21.9 per cent of the 314 metastatic tumors were resectable. Other considerations reduced the operability to 11.9 per cent. Actually, surgery was done in only 2 cases, or 0.63 per cent. In each instance the tumor was a sarcoma and the 2 patients are alive and well four and seven years after pulmonary resection.

Eight roentgenograms; 1 chart; 4 tables.

HAROLD O. PETERSON, M.D.  
University of Minnesota

**Tumors and Cysts of the Mediastinum.** William S. Conklin. *Dis. of Chest* 17: 715-740, June 1950.

Many tumors and cysts may be found in the mediastinum, both primary and secondary. The author discusses and illustrates some of the more important ones, emphasizing management, since all mediastinal neoplasms are regarded as being potentially malignant. Esophageal lesions are not included.

Symptoms and signs of mediastinal tumors and cysts are the result of an expanding mass producing compression and displacement of adjoining structures. In the course of time, there is a sense of fullness or tightness in the chest, and eventually pain. Depending upon its location, the tumor may cause cough, wheezing, dyspnea, atelectasis, or bronchopulmonary suppuration. Erosion into a bronchus or lung may lead to hemoptysis or severe hemorrhage. Cysts rupturing into a bronchus will discharge their contents. With malignant growths the usual constitutional manifestations are present—loss of weight, anemia, and fever. Vascular compression is manifested by dilated neck veins and collaterals on the chest wall. Nerve involvement may result in unequal pupils, a complete Horner's syndrome, hoarseness, vocal cord paralysis, or paralysis of a hemidiaphragm. Compression of the esophagus will cause dysphagia.

Demonstration of the mediastinal tumor or cyst is dependent on fluoroscopy or roentgenographic examination. A well defined lesion which is predominantly unilateral is likely to be benign and operable, while one which is ill defined and bilateral is more likely to be malignant, with infiltration and invasion of surrounding structures.

The problem of differential diagnosis resolves itself essentially into determining whether a given tumor is a lymphoblastoma or a metastatic cancer, in which case surgery is out of the question, or whether it is a benign or malignant primary neoplasm for which surgical cure may be feasible.

In the anterior mediastinum one usually encounters the teratodermoid tumors and cysts, tumors of the thymus, hyperplastic or adenomatous thyroid and parathyroid glands, and pericardial cysts; in the mid-mediastinum, bronchogenic and gastro-enterogenous cysts, lymphomas, and metastatic tumors; in the posterior mediastinum, tumors of nerve origin, such as neurofibromas and ganglioneuromas.

Non-neoplastic lesions occurring in the mediastinum which must be considered in the differential diagnosis, and for which surgery may be indicated, are meningoceles, tuberculomas, echinococcal cysts, abscesses, and aneurysms. Lesions for which surgery is not indicated include the lymphoblastomas, Boeck's sarcoid, and metastatic cancer.

The outstanding features of the various neoplastic and cystic lesions occurring in the mediastinum are summarized, and the findings in a series of 29 cases are very briefly presented.

Thirty-seven roentgenograms; 3 photographs.

HENRY K. TAYLOR, M.D.  
New York, N. Y.

**Pleural Effusion Produced by Abdomino-Pleural Communication in a Patient with Laennec's Cirrhosis of the Liver and Ascites.** M. Henry Williams, Jr. *Ann. Int. Med.* 33: 216-221, July 1950.

The following case is reported as an example of pleural effusion apparently due to rupture of the diaphragm in a patient with long-standing ascites as a result of Laennec's cirrhosis of the liver.

The patient, a woman of 37, complained of rapidly progressive abdominal swelling during the preceding five weeks, and the abdomen was found to be distended with ascitic fluid. Several paracenteses were performed, with the removal of a progressively sanguineous transudate. Cultures of this material were repeatedly negative for tubercle bacilli and cell blocks failed to show tumor cells on three occasions. To eliminate the possibility of an ovarian tumor, an exploratory laparotomy was done. No tumor was found. The liver was observed to be grossly typical of Laennec's cirrhosis, and microscopic examination of a biopsy specimen confirmed this diagnosis.

During the twenty-first week of the patient's hospital stay, a dry, hacking cough developed and the temperature rose to 102°. Physical signs of an extensive right pleural effusion were detected and confirmed by x-ray examination, and 1,000 c.c. of serosanguineous fluid was removed from the right chest. One week later, following spontaneous disappearance of the cough and fever, 1,000 c.c. of fluid were again withdrawn from the right chest. A blue dye (T 1824) was injected intra-abdominally and was found in large amounts in chest fluid obtained forty minutes later.

Fluid was again removed from the right chest a week later, following which a residual pleural effusion was still apparent on x-ray examination. Fifteen hundred cubic centimeters of oxygen were then injected into the peritoneal cavity. Fifteen minutes after the pneumoperitoneum, a chest film showed a pneumothorax with 25 per cent collapse of the right lung.

Only one case of pleural effusion due to rupture of the diaphragm (proved at autopsy) in a patient with cirrhosis of the liver has been reported previously. In that instance antecedent trauma was severe. In the present case, rupture of the diaphragm was suggested by the sudden development of a massive pleural ef-

fusion and was confirmed by the passage of dye and air from the abdomen to the chest. It is conceivable that an underlying defect in the diaphragm led to this event.

Four roentgenograms; 1 table.

STEPHEN N. TAGER, M.D.  
Urbana, Ill.

**Extrapleural Fluid Complicating Thoracic and Thoracolumbar Sympathectomy.** Magnus I. Smedal and Samuel W. Lippincott. *S. Clin. North America* 30: 829-836, June 1950.

In 21 patients undergoing sympathectomy, roentgen examination showed pleural effusion alone in 2; in 8 both intrapleural and extrapleural reaction developed; 10 showed only extrapleural densities. In 1 there was a combination of pleural effusion, small loculated hydro-pneumothorax, and an extrapleural effusion.

The extrapleural densities are of two types. The first is sharply demarcated and is convex in all diameters away from the vertebral border or mediastinum. The second is a diffuse paravertebral density, not sharply demarcated, although the two types may shade one into the other. The second type seems to fan out from the hilus; the lung markings are not prominent, and in lateral films the posterior aeration of the lung fields is obscured.

Three cases are presented. In all the clinical picture was mild. Aspiration was done only in the early cases and yielded from 0 to 180 c.c. of serosanguineous fluid. Usually the fluid disappeared in from two weeks to one month.

Twenty-one roentgenograms; 1 table.

R. JEAN ROMER, M.D.  
Baton Rouge, La.

**A Case of Intrathoracic Lipoma in the Dome of the Pleura.** Erwin Dissmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 73: 102-104, May 1950. (In German)

Lipoma in the apex of the pleura is an extremely rare finding. The case of a 14-year-old boy is reported with a two-year history of pain in the shoulder girdles and a tendency to shortness of breath, with slight fatigue on exertion. The previous history indicated some form of inflammatory process involving the lung and ribs, details of which were not stated. X-ray studies showed an area of increased density in the apex of the lung field extending below the clavicle, with a sharply demarcated convex lower border and of homogeneous density. There was no erosion of spine or ribs. Pleural tumor, loculated exudate, and cold abscess were considered in the differential diagnosis. Attempt at puncture biopsy gave an impression of consistency similar to butter; no blood or air was reached in the interior of the tumor.

Diagnostic pneumothorax showed retraction of the lung apex from this area, and the tumor fixed to the upper portion of the mediastinal structures. The relationship of the tumor had not been determined by tomography.

Thoracoscopy showed a bilobed tumor with smooth surface, and a strong presumptive diagnosis of lipoma could be established.

The value of diagnostic pneumothorax, tomography, puncture biopsy, and thoracoscopy as adjuncts to the usual conventional x-ray studies is pointed out.

Three roentgenograms. E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Angiocardiography in Infants and Children.** New Technic. John D. Keith and John D. Munn. *Pediatrics* 6: 20-32, July 1950.

An angiocardiographic apparatus is described which permits taking four roentgenograms per second. Rapid serial roentgenography gives more information than a single film because the passage of the opaque substance through the chambers of the heart can be recorded in sequence. Furthermore, one may go over a group of roentgenograms and select the best film or films to show the defects present. This method of investigation of congenital heart lesions has proved most useful in studying the cyanotic group and in demonstrating shunts from right to left.

Angiocardiograms are reproduced—and discussed—from cases of tetralogy of Fallot, transposition of the great vessels, dextrocardia, large septal defect with transposition, tricuspid atresia, persistent truncus arteriosus, the Taussig heart, an anomalous inferior vena cava entering the superior vena cava, and large interauricular septal defect.

Twenty-five roentgenograms; 4 photographs.

HOWARD L. STEINBACH, M.D.  
University of California

**Table for Routine Angiocardiography.** Synchronous Serial Roentgenography in Two Planes at Right Angles. O. Axén and John Lind. *J. A. M. A.* 143: 540-542, June 10, 1950.

By means of the table here described, films can be exposed simultaneously in two planes at right angles at a rate of one or two per second. Cassettes are transferred from the magazine to the exposure fields and removed automatically. An electrocardiogram is made throughout the operation in order to fix precisely the time between the exposures and, still more important, to register the heart phases in which the exposures have been made.

Some films are reproduced, showing the structure of the heart and great vessels in a much more complete manner than a single projection. Many repeated injections will be saved by such a set-up.

[Scott, in his Carman Lecture on *The Development of Angiocardiography and Aortography* (*Radiology* 56: 485, April 1951) describes a number of devices, including one of his own, for making exposures in two planes on roll film.—Ed.]

Eight roentgenograms; 4 photographs.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Transposition of the Great Vessels.** Diagnostic Use of Angiocardiography in a Newborn Infant. Harold Abramson. *Am. J. Dis. Child.* 79: 1063-1072, June 1950.

Complete transposition of the great vessels and patent foramen ovale, with closed ductus arteriosus and intact interventricular septum, is one of the rarer causes of cyanosis in early infancy. According to Halpert and Cushing (*Am. J. Dis. Child.* 74: 476, 1947. *Abst. in Radiology* 51: 281, 1948), only 13 instances of this malformation have been recorded in the literature. An additional case is described in this report, with a discussion of the diagnostic use of angiocardiography.

The child was born about two weeks prior to term. At birth he breathed satisfactorily and had a vigorous cry, but cyanosis developed promptly. About twelve

hours after birth, the cyanosis deepened and respirations became labored. The baby was placed in an incubator and oxygen was administered. On the following day the heart and lungs were clear and a roentgenogram of the chest was negative. The cardiac silhouette appeared normal. The tentative clinical diagnosis was possible transposition of the great vessels, with the thought that, to sustain life, a compensatory shunt was necessary between both sides of the heart.

A second attack of acute respiratory distress and intensification of the cyanosis occurred at the age of twenty-five days, and for the first time a systolic murmur was heard, which was loudest in the third left interspace within the nipple line, with transmission upward, outward, and around to the angle of the scapula. A pitting edema of the legs and feet was present. Fluoroscopy now revealed moderate enlargement of the heart. The aorta was in its normal position with reference to the barium-filled esophagus.

Angiocardiography was carried out (by Dr. Morris Steinberg) on the forty-second day of life, and the child died three days later from cardiac failure. A roentgenogram taken shortly before death showed a tremendously dilated heart and infiltration in both pulmonary fields.

The angiocardiographic findings were as follows: In the roentgenogram taken 1.5 seconds after the injection, the radiopaque medium filled the dilated right atrium and ventricle, as well as the entire aorta with its cervical, thoracic, and abdominal branches. The pulmonary arterial system was not opacified. No opaque substance was seen in the region of the left ventricle. A small vascular structure in the area of the aortic window was seen indistinctly and was interpreted as representing the left pulmonary artery. At the base of the intracardiac portion of the aorta, a large sac-like projection was construed as a dilated infundibulum of the right ventricle. The pulmonary arterial branches were not opacified until 2.5 seconds after the injection and they remained opaque approximately 6 seconds.

These observations suggested the presence of an aorta that communicated directly with an enlarged right ventricle and that was associated with an atresia or pronounced stenosis of the pulmonary artery. Although an interventricular septal defect was not demonstrated, the picture was thought possibly to represent a variant of the tetralogy of Fallot.

The postmortem examination showed a congenital malformation of the heart, consisting of complete transposition of the aorta and pulmonary artery, a patent foramen ovale and a closed ductus arteriosus, with an intact interventricular septum. The right atrium and right ventricle were hypertrophied. Pulmonary emphysema and atelectasis were present.

The clinical picture was explained by the complete transposition of the great vessels, with the patent foramen ovale as the only possible means of shunting blood between the right and left sides of the heart. Although the ductus arteriosus may have been functionally patent at birth, closure probably occurred shortly thereafter, as was demonstrated by complete obliteration and calcification of the lumen at the time of autopsy, forty-five days after birth. Life was, therefore, dependent upon a small volume of oxygenated blood which passed from the left to the right through the foramen ovale for eventual systemic distribution. This direction of flow

was conditioned by the development of a satisfactory pressure gradient between the atria.

Three roentgenograms; 2 photomicrographs; 2 diagrams.

HUGH A. O'NEILL, M.D.  
Cleveland, Ohio

**Experiences with the Use of Direct Aortography in the Diagnosis of Coarctation of the Aorta.** William H. Muller, Jr., and Robert H. Sloan. *J. Thoracic Surg.* 20: 136-141, July 1950.

Roentgenologic contrast visualization gives more information about coarctation of the aorta than any other diagnostic procedure. Methods which have been used include (a) intravenous injection of the contrast medium, (b) intra-arterial retrograde injection after surgical exposure of the left common carotid, (c) catheterization of the ascending aorta through the right or left radial artery. The authors report four months experience (13 patients) with catheterization of the descending aorta through the left radial artery. Their procedure is technically simple, requires only 25 c.c. of 70 per cent diodrast, avoids the chance of occluding a coronary artery with the catheter tip, and assures placement of contrast medium just above the coarctation. Its disadvantages are poor visualization of the ascending aorta and first part of the aortic arch, and the occasional (3 of their 13 cases) penetration of the catheter tip into the coarctated segment, with danger of injury to that abnormal segment. A dissecting aneurysm discovered at operation in one patient was attributed to the procedure.

Three roentgenograms; 2 drawings.

HAROLD O. PETERSON, M.D.  
University of Minnesota

**A Case of Turner's Syndrome with Coarctation of the Aorta and a Pulmonary Arteriovenous Aneurysm.** Harris Jackson. *South African M. J.* 24: 423-424, June 3, 1950.

Turner's syndrome consists of webbed shoulders, primary ovarian agenesis, and cubitus valgus. The case reported here included, in addition to these features, coarctation of the aorta and a pulmonary arteriovenous aneurysm. The blood pressure was elevated in the arms but was unobtainable in the legs.

The chest film showed no rib notching and no recognizable aortic knob but a dilated (post-stenotic) descending aorta and a prominent left subclavian artery. In the right lung field was a pulsating mass which changed in size during Valsalva and Mueller maneuvers and was shown by tomography to be connected to the hilus by a thick leash of vessels. No mention is made of treatment.

Five roentgenograms. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**High Right-sided Aorta: A Three Dimensional Laminagraphic Study.** Luigi Oliva. *Radiol. med.* (Milan) 36: 500-508, June 1950. (In Italian)

The author has studied a case of right-sided aortic arch by the technic described by Vallebona (see *Radiology* 55: 271, 1950), namely, cross-sectional horizontal laminagraphy. This procedure is especially useful in the study of thoracic organs. Several views are reproduced showing the relationship of the anomalous aorta to the trachea and to the bronchi.

Six roentgenograms. CESARE GIANTURCO, M.D.  
Urbana, Ill.



**Ebstein's Anomaly of the Tricuspid Valve. Report of Three Cases and Analysis of Clinical Syndrome.** Mary Allen Engle, Torrence P. B. Payne, Caroline Bruins, and Helen B. Taussig. *Circulation* 1: 1246-1260; June 1950.

Including the 3 in this report, 26 cases of Ebstein's anomaly of the tricuspid valve have appeared in the literature. None has been diagnosed in life, but the authors set forth the outstanding features in such a way that the diagnosis would seem to be possible.

The anomaly consists basically of displacement of the tricuspid valve downward into the ventricle, actually converting part of the ventricle into a thin-walled extension of the auricle. The valve itself is somewhat deformed, becoming adherent to the wall of the ventricle but remaining functionally competent. The encroachment on the right ventricle prevents it from receiving the proper amount of blood, which accumulates in the auricle. The auricle is thus distended and enough pressure is usually built up to open the foramen ovale, shunting blood to the left auricle. The result is a deficient pulmonary circulation with consequent limitation of exercise. When sufficient unoxygenated blood is shunted through the foramen ovale to the systemic circulation, cyanosis appears.

The history is that of delayed onset of cyanosis and easy fatigability, but these patients do not have the habit of squatting to rest. There is slight clubbing and the heart is enlarged, with muffled sounds and often gallop rhythm. Pulse pressure is narrow. Liver enlargement is slight.

Fluoroscopically, the marked enlargement of the right heart and diminished pulsations are demonstrable. There is no fullness of the pulmonary conus; the pulmonary artery is of normal size but shows no expansile pulsations. The esophagram is normal. The lung fields are unusually bright.

Angiocardiography shows the huge right auricle with delay in passage of the dye into the ventricle. Passage is so slow that the pulmonary vessels are never properly opacified. If there is a sufficient shunt, the left heart and aorta are visualized early. Cardiac catheterization is considered dangerous because of the thinness of the wall of the right auricle and the possibility of starting a fatal arrhythmia. If done, it shows a reduced pulmonary flow, right to left auricular shunt, and normal pressure in the right ventricle.

Circulation time is prolonged; there are compensatory polycythemia and arterial oxygen unsaturation. The electrocardiogram shows right bundle branch block and prolonged auricular-ventricular conduction time.

It is important to recognize this condition, since it is not one which can be helped by surgery. The chief features distinguishing it from the tetralogy of Fallot are the extreme right auricular enlargement, the delayed onset of cyanosis, the absence of squatting and paroxysmal dyspnea, and the electrocardiographic changes.

Eight roentgenograms; 2 drawings; 2 photomicrographs.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Roentgenographic Appearance of Interatrial Septal Defect. A Report of Twelve Cases.** R. F. Healey, J. W. Dow, M. C. Sosman, and L. Dexter. *Am. J. Roentgenol.* 63: 646-656, May 1950.

The article is best reviewed by quoting the authors' excellent summary.

"An analysis was made of the roentgenographic and hemodynamic changes observed in twelve cases of interatrial septal defect.

"Significant roentgenographic findings included cardiac enlargement, right atrial and right ventricular enlargement, and dilatation and hyperactivity of the pulmonary artery. The aorta appeared small in three cases. Left atrial enlargement was not observed. In seven cases, posterior enlargement of the right ventricle simulated left ventricular enlargement.

"A correlation of the roentgenographic appearance with the hemodynamic changes revealed that a small left-to-right shunt through an atrial defect produced no recognizable changes in the heart or pulmonary artery. A large shunt usually resulted in marked changes, but an exception was noted. Small interatrial shunts associated with marked pulmonic hypertension were indistinguishable roentgenographically from larger interatrial shunts without marked pulmonic hypertension. Aneurysmal dilatation of the pulmonary artery, usually associated with Lutembacher's syndrome, was found in one case without a lesion of the mitral valve at necropsy.

"A differential diagnosis based on the roentgenographic appearance is given."

Eighteen roentgenograms; 1 table.

D. C. GASTINEAU, M.D.  
Indiana University

**Pericardial Effusion with Myxedema (Myxedema Heart).** S. Schmidt. *J. de radiol. et d'électrol.* 31: 428-429, 1950. (In French)

In 1918 Zondek described the cardiac phenomena which accompany certain cases of myxedema. Usually there are enlarged cardiac volume, diminished cardiac sounds, and reduced amplitude of pulsations seen fluoroscopically and revealed in the electrocardiogram. These cardiac phenomena are generally explained as being due to cardiac dilatation, accompanied at times by pericardial effusion.

The author presents the case of a 48-year-old male with precordial pain and dyspnea. Signs of hypothyroidism were present. Radiologic examination revealed a large, flask-shaped heart with diminished pulsations. Upon pericardial puncture, 250 c.c. of clear fluid were obtained. After thyroid therapy the transverse cardiac diameter became smaller by 2 cm. and other signs and symptoms of hypothyroidism disappeared.

Three roentgenograms.

CHARLES NICE, M.D.  
University of Minnesota

## THE DIGESTIVE SYSTEM

**Congenital Oesophageal Atresia with Tracheo-Oesophageal Fistula. A Report of 5 Cases and a Plea for Early Diagnosis.** Brian Donnelly. *Lancet* 1: 666-669, April 8, 1950.

Although it has been estimated that one in every 2,650 infants is born with atresia of the esophagus, the author states that there are probably not more than two or three patients surviving in Great Britain. Five fatal cases, all of Vogt's type 3b (atresia of the esophagus with a fistula between the lower esophageal segment and the trachea), are reported in the hope that they will help others to make an early diagnosis. The technic of roentgen examination is described. Besides confirming the diagnosis, the roentgenograms will reveal



the condition of the lungs and demonstrate associated congenital anomalies.

One roentgenogram.

**Concerning the Differential Diagnosis of Esophageal Varices.** M. Pietro Cignolini. *J. de radiol. et d'électrol.* 31: 413, 1950. (In French)

In studying esophageal varices the Valsalva maneuver has two opposing effects: enlargement of the varices by stasis and diminution because of direct pressure of the mediastinal wall upon the esophagus. Westermarck and Laurell have used a water manometer connected with a tube to the patient's mouth to regulate the positive pressure at 40-60 cm. of water. This controlled pressure method has improved the author's results in detecting varices.

CHARLES NICE, M.D.  
University of Minnesota

**Roentgenkymographic Study of Disturbances in Motility and of Esophageal Lesions in Scleroderma.** M. A. Lura. *J. de radiol. et d'électrol.* 31: 417-419, 1950. (In French)

Scleroderma involves not only the skin and subcutaneous tissues, but also the circulatory, respiratory, digestive, urinary, and nervous systems, as well as affecting the liver and spleen.

Roentgenkymographic studies of the esophagus have shown not only epicardial stenotic lesions with hypotonus above, but also have demonstrated absence of peristaltic involvement in advanced cases and revealed transmitted pulsations from nearby pulsatile organs.

Five roentgenograms; 5 roentgenkymograms.

CHARLES NICE, M.D.  
University of Minnesota

**Achalasia (Cardiospasm). Report of a Case with Extreme and Unusual Manifestations.** C. T. Bello, J. R. Lewin, C. M. Norris, and G. E. Farrar, Jr. *Ann. Int. Med.* 32: 1184-1190, June 1950.

Achalasia (cardiospasm) is not a rare condition. It is usually seen in the middle-aged individual and is characterized clinically by symptoms of dysphagia, regurgitation of food, and epigastric discomfort. Certain unusual manifestations not previously described were observed in the case reported here, namely, hoarseness which disappeared in the supine position and extreme dilatation of the cervical component of the esophagus, giving rise to a so-called "bull-frog appearance."

A white woman, 75 years of age, gave a long history of recurrent attacks of sudden generalized thoracic compression and a sensation of abdominal distention. The attacks lasted from five minutes to two hours and were relieved or partially relieved by assumption of the supine position and eructation. Dysphagia was present only during the attacks. Following these episodes, hoarseness developed, which disappeared when the supine position was assumed. Two years before the patient was seen, a mass appeared in the left side of her neck during one of the attacks. The mass enlarged with coughing and straining and slowly increased in size until its transverse diameter measured 10 cm. There was a history, also, of a considerable weight loss during the past two years.

Physical examination revealed a smooth bilateral swelling at the base of the neck. On the left side it measured 7 cm. in diameter. It was bounded super-

riorly by the horizontal ramus of the mandible, inferiorly by the clavicle, posteriorly by the anterior border of the sternocleidomastoid muscle, and medially by the trachea. This prominence was soft, fluctuant, non-pulsating, non-reducible, and hyperresonant, and upon palpation gave the impression of a cyst filled with air. It was not fixed nor adherent to the trachea.

Roentgen examination showed the esophagus to be tremendously enlarged and tortuous in its entire length. The dilatation was maximum in the upper portion, where the food passage was in contact with the right lateral chest wall. The cervical esophagus was similarly affected, appearing as a large air-filled structure measuring over 8 cm. in width, narrowing and displacing the trachea anteriorly. An interesting feature of the dilatation of the upper food passage was the elevation and attenuation of the cricopharyngeus. Re-examination, following aspiration of the esophageal contents and oral administration of a barium sulfate-water mixture, again demonstrated the severe degree of dilatation and tortuosity of the esophagus, particularly in its upper thoracic portion. The impression was severe cardiospasm of long duration.

The esophagoscopic findings were those of advanced "cardiospasm." Although the esophageal walls seemed unusually redundant, the mucosal surface showed little inflammatory change and no ulceration was observed.

Distortion and kinking of the tremendously dilated upper thoracic esophagus were such that the simpler instruments commonly used for dilatation could not be advanced to the hiatal level, despite maneuvers under roentgenoscopic guidance with the patient in various positions. Attempts with a pneumatic dilator adapted for introduction over a previously swallowed string of woven silk were somewhat more successful. Due to the nearly horizontal course of the terminal portion of the esophagus, however, the dilator could be advanced only part way to the optimum position for inflation.

Four roentgenograms; 2 photographs.

STEPHEN N. TAGER, M.D.  
Urbana, Ill.

**Foreign Bodies in the Gastrointestinal Tracts of Psychotic Patients.** Louis Carp. *Arch. Surg.* 60: 1055-1075, June 1950.

Eleven operative and 13 non-operative cases of swallowed foreign bodies in the gastro-intestinal tracts of psychotic patients are reported from the Rockland Hospital, New York. In one-half of the patients the diagnosis was dementia praecox. As far as could be ascertained, at least one-half were symptom-free, probably because of their psychiatric condition, and attention was drawn to the case merely by chance or by a sudden catastrophe. Bizarre metallic objects predominated. In all but 7 cases the foreign bodies were multiple. They were characterized by their extraordinary composition, size, shape, weight, length and traumatic edges.

The roentgen and clinical findings, the indications and preparation for surgery, and the operative findings and techniques are discussed. In all the cases in this series radiopaque shadows were demonstrable, but at operation the foreign body was frequently found to have changed position, due perhaps to its own movement or a shift in the position of an intestinal loop.

Eight roentgenograms; 4 photographs; 4 tables.

DANIEL WILNER, M.D.  
Atlantic City, N. J.

**Benign Disease of the Antral Portion of the Stomach.** Charles A. Flood. *Gastroenterology* 15: 399-406, July 1950.

Benign antral disease, usually first revealed by roentgen examination, is most commonly associated with an active peptic ulcer or appears as a sequel of an ulcer. Radiographic findings are prepyloric narrowing, abnormal and irregular peristalsis, exaggeration or diminution in the caliber of mucosal folds, delay in emptying, and in some cases evidence of hypertrophy of the pylorus. These findings may occur with an ulcer of the antral portion of the stomach or on the lesser curvature, and the abnormal appearance of the antrum usually persists after the ulcer is healed.

The present study, from the Presbyterian Hospital, New York, is based on 42 cases. The clinical picture was the same as that usually encountered in a simple peptic ulcer, commonly with periods of remission and exacerbation. In 32 cases radiologic examination showed persistent narrowing of the outline of the antrum. In 6 other cases there was a deformity of the outline of either the lesser or greater curvature of the antrum without diffuse constriction. A shadow of a prepyloric crater without diffuse narrowing or other significant deformity was the chief x-ray finding in the other 4 patients. Disappearance of the antral deformity was noted in only 2 patients in follow-up examination.

Gastroscopecally, chronic gastritis was found to be present in 19 cases, the gastritic changes being more frequent in the body of the stomach than in the antrum. Peptic ulcer was visualized in 6 patients. In 20 cases the gastric mucosa appeared normal.

Pathological studies were done in 15 cases (14 operative specimens, and 1 autopsy), and in 11 of these active ulcer was found. Thirty-three of the entire series had evidence of ulcer at the time of the study or history of an ulcer on previous examination, most commonly in the antrum.

From the gastroscoptic studies it appears that the constriction of the antrum is due, as a rule, to smooth muscle spasm.

Two roentgenograms; 3 tables.

WENDELL WARD, M.D.  
University of Arkansas

**Chronic Intermittent Benign Dilatation of the Stomach.** Richard Jahiel and Daniel J. Feldman. *Am. J. Digest. Dis.* 17: 203-207, June 1950.

Retention of gastric contents for a period of twenty-four hours or more is usually indicative of an organic obstruction. Retention of gastric contents for six to twelve hours may be due to spasm of the pylorus secondary to infection or psychogenic stress. This paper reports two cases of intermittent complete retention of gastric contents for over twenty-four hours without demonstrable cause.

The first patient, a 40-year-old colored male, entered the hospital in September 1946, because of periodic attacks of epigastric pain relieved by food. On x-ray examination, a small gastric ulcer was found on the lesser curvature side of the stomach just proximal to the pylorus, which responded readily to treatment. In March 1947, the patient was again admitted with the same complaints and a feeling of fullness. X-ray examination at this time revealed a markedly dilated stomach. Although the pylorus was patent and the duodenal cap filled well, no barium had left the stomach

when the twenty-four hour film was taken. Normal free and total acid curves were found on gastric analysis. The patient was placed on a Sippy diet, with lavage six hours after meals. In one month, the size of the stomach had returned to normal. A year later there was a recurrence of symptoms and marked dilatation of the stomach, and complete retention was again found on x-ray examination. Symptoms once more disappeared under treatment.

The second patient, a white female 41 years old, was first seen in 1932 with acute epigastric pain and fever. X-ray examination revealed a dilated atonic stomach with no obstruction of the pylorus and a well filled duodenal cap. A twenty-four hour film showed almost complete retention. There was complete achlorhydria, and on gastroscoptic examination the mucosa was seen to be thickened and red. The patient was placed on a bland diet and sedation and ice bags were applied to the abdomen. Her condition improved, and a laparotomy was performed. Enlarged lymph nodes were present along the lesser curvature side of the stomach but otherwise the findings were normal. The attacks of pain continued, and gastric dilatation was demonstrated roentgenologically on several occasions. Because of these attacks, a partial gastrectomy was performed. The patient made an uneventful recovery and has had no further gastric distress. Histologic examination of the surgically removed stomach failed to reveal any morphologic abnormality of the muscularis or the pyloric sphincter.

Chronic intermittent gastric dilatation may be considered a complication of gastric disorders. In the authors' second case a possible explanation is to be found in Stokes' law that the muscularis below an inflamed mucosa is temporarily paralyzed. In the first case, in which a gastric ulcer was the fundamental abnormality, the concomitant gastritis may possibly have played a part, but benign dilatation is not a common complication of ulcer, whereas an associated gastritis is, so that too much emphasis cannot be placed on this mechanism.

Nine roentgenograms; 1 photomicrograph.

JOSEPH T. DANZER, M.D.  
Oil City, Penna.

**Carcinoma of the Cardiac Portion of the Stomach.** D. Berger. *J. Canad. A. Radiologists* 1: 20-24, June 1950.

Since the advent of the surgical transthoracic approach for cancer of the cardiac portion of the stomach, the early diagnosis of this lesion has become even more important. These tumors remain silent for a long time and give rise to obstructive symptoms only when they are well advanced. Radiologic examination of the cardia is difficult, as this part of the stomach is not accessible to direct palpation and pressure. Direct fluoroscopic observation and fluorographic studies are therefore of greater importance than in the body and antrum, which can be easily palpated. Very often the picture will change in the course of the examination, as the increased amount of gastric fluid due to hypersecretion may wash off the thin coat of barium from the surface of the mucosa of the fundus, thus removing the only evidence of a tumor. Because of the variability of the mucosal pattern in this region, a polypoid or ulcerating tumor is more easily detected than an infiltrating growth.

Roentgenograms in 8 cases of cancer of the cardiac

portion of the stomach are reproduced. Seven of these cases showed a definite deformity of the gastric gas shadow, which is significant if not entirely diagnostic. In one of this number the lesion was suspected on routine chest investigation but was overlooked during examination of the stomach. The tumor was discovered during a laparotomy for cholecystitis and later was resected via the transthoracic route. In the 8th case the cancer was in a herniated portion of the cardia.

Sixteen roentgenograms.

**Sarcoma of the Stomach.** Samuel F. Marshall and William A. Meissner. *Ann. Surg.* 131: 824-837, June 1950.

Sarcoma of the stomach, while not common, occurs often enough to be considered in the differential diagnosis of tumors of the stomach. A clinical analysis is presented of 41 cases seen over a period of twenty years in the Lahey Clinic, Boston, representing 3.7 per cent of malignant lesions of the stomach.

Sarcomas may arise from any mesenchymal tissue component of the stomach, but for practical purposes there are only two types, those arising from smooth muscle and those from lymphoid tissue. While it may occur at any age, sarcoma is usually seen earlier in life than carcinoma.

Roentgen studies were made in all the cases in this series. In the 9 cases of leiomyosarcoma, the x-ray diagnosis was leiomyoma in 4, benign tumor in 2, and carcinoma in 3. In the lymphoid group a preoperative diagnosis of sarcoma was made in only 1 of 32 cases, but was suspected in 2 others.

The roentgen examination of tumors arising from lymphoid tissue shows no characteristic findings, but Feldman (Clinical Roentgenology of the Digestive Tract, Baltimore, Wm. Wood & Co., 1938) has listed certain signs which might be helpful as suggesting a diagnosis of lymphosarcoma: (1) a filling defect with smooth margins, (2) a localized type of tumor which is round and smooth, (3) in the diffuse type of tumor, involvement of large portions of stomach simulating linitis plastica, (4) mucosal rugae in thick folds, (5) the presence of palpable tumors in young individuals, and (6) the presence of multiple ulcers. However, roentgen examination may reveal no abnormality.

Leiomyomas may have a more characteristic appearance. They are often diagnosed as benign polypoid tumors of the stomach and present a circumscribed globular filling defect.

Treatment is by radical surgery, with postoperative irradiation for tumors arising from lymphoid tissue. The prognosis is good. A 44 per cent five-year survival was obtained in this series.

Eight roentgenograms; 3 photomicrographs; 1 photograph; 6 tables.

EDSEL S. REED, M.D.  
Louisville, Ky.

**The Sarcomas of the Stomach: A Review with Reference to Gross Pathology and Gastroscopic Manifestations.** Eddy D. Palmer. *Am. J. Digest. Dis.* 17: 186-195, June 1950.

Among 12,073 cases of malignant tumors of the stomach reported by twenty authors, there were only 148 sarcomas. In a collection of 500 gastric sarcomas, 42 per cent were lymphosarcomas and 20 per cent leiomyosarcomas; reticulum-cell sarcoma, Hodgkin's disease, and myxosarcoma were each found in slightly

less than 10 per cent of the total, and other types in still lower percentages.

This paper deals chiefly with the gastroscopic aspects of this unusual tumor. In an attempt to secure more information about it, the author has gathered together from the literature 124 cases in which gastroscopy was done and has analyzed the findings.

The general form of gastric sarcoma is classified under five headings: (1) diffusely infiltrating tumor; (2) tumor plaque with projecting nodule; (3) single discrete tumor; (4) ulcerating tumor; (5) lobulated fungating tumor. A study of the site of the lesions showed them to be surprisingly uniformly situated throughout the stomach, so that their position is of no diagnostic significance.

The gastroscopic features of the various types of sarcoma are presented.

Three roentgenograms; 1 schematic drawing; 8 tables.

JOSEPH T. DANZER, M.D.  
Oil City, Penna.

**Reticulum Cell Sarcoma of the Stomach. Report of a Case in a Young Woman.** Louis L. Perkel and Benjamin J. Macchia. *Gastroenterology* 15: 525-529, July 1950.

A case of reticulum-cell sarcoma of the stomach in a woman of twenty-one is reported. Repeated roentgen examinations showed an ulcer crater on the lesser curvature, with thickened rugal folds converging toward it, strongly suggesting carcinoma. Surgery was eventually performed, revealing a large non-resectable growth involving the lesser and greater curvatures of the stomach and adherent to the anterior abdominal wall. Biopsy showed it to be a reticulum-cell sarcoma, and autopsy further confirmed the diagnosis.

One roentgenogram.

**Primary Malignant Lymphoid Tumors of the Stomach.** Samuel F. Marshall and Lowell Brown. *S. Clin. North America* 30: 885-892, June 1950.

In a series of 406 operations for malignant tumors of the stomach at the Lahey Clinic (Boston) from 1941 to 1945, 16 sarcomas of the stomach were found. Two of these were leiomyosarcomas; the remaining 14 were tumors of lymphoid origin. There were also 8 cases of localized Hodgkin's disease, an unusually high incidence. The total incidence of non-carcinomatous malignant disease was thus 4 per cent, or one in every 25 patients operated upon for malignant disease of the stomach. The series upon which the present report is based includes 23 lymphoid tumors seen up to January 1946: 9 lymphosarcomas, 8 Hodgkin's disease, 4 malignant lymphomas, 2 reticulum-cell sarcomas.

There were no features of history, physical examination, or laboratory findings to distinguish these patients from those with carcinoma. Only 4 cases were considered inoperable, biopsy alone being carried out. Thirteen subtotal and six total resections were done, a resectability rate of 83 per cent. Ulceration was found in seven specimens. Nineteen cases were believed to be carcinoma at the operating table. Lymph node involvement was noted in 8 of these.

There were three hospital deaths. One of these followed minor surgery six months after the primary operation and necropsy revealed widespread disease.

Seven patients were alive and well five years or more after operation. Four others were alive six months to

three years after operation. Thus, while results are poor, they are distinctly better than for carcinoma of the stomach.

One patient on whom total gastrectomy was performed, with a diagnosis of "lymphosarcoma" and involvement of twenty-two of thirty-one lymph nodes, is in vigorous health seven years after operation.

Five patients received x-ray therapy. One with a biopsy diagnosis of "malignant lymphoid tumor, probably Hodgkin's disease" did fairly well for three years but now has generalized Hodgkin's disease five and one-half years after operation. Three patients with "Hodgkin's disease," "lymphoblastoma, probably reticulum-cell sarcoma," and "probably Hodgkin's disease" survived three months, four months, and a year, respectively. A fifth patient with lymphosarcoma was given x-ray therapy as a last resort and without benefit during the last three months of his two-year seven-month survival. A twenty-nine-year-old male, not included in the series of 23, was treated preoperatively for a filling defect of the antrum under a clinical diagnosis of lymphoma. The pathologic diagnosis was "unclassified necrotic tumor," which suggested sarcoma. He survived seven years and died of an adenocarcinoma of the jejunum with metastases. The authors believe the second tumor was unrelated to the first.

Radical surgery is recommended, as a definite diagnosis cannot be made before operation. All inoperable tumors should be biopsied as there is occasional long-term survival following x-ray therapy.

One roentgenogram; 1 photograph; 3 tables.

R. JEAN ROMER, M.D.  
Baton Rouge, La.

**Leiomyomata of the Stomach.** Frank Greenwood and Eric Samuel. *South African M. J.* 24: 416-418, June 3, 1950.

Leiomyomata are the most common of the benign tumors of the stomach. Anatomically they may be endogastric or exogastric, or both components may be present. Sarcomatous degeneration and hemorrhage are two serious complications which render surgery advisable when the diagnosis is made.

X-ray examination shows a smooth, often lobulated filling defect, usually with a central ulcer crater. The mucosa overlying the mass is seen to be flattened but not infiltrated. The presence of sarcomatous degeneration cannot be detected radiologically.

Three cases are reported, one of which showed sarcomatous changes.

Four roentgenograms. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Neurofibromatosis of the Stomach.** Karl Böck. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 73: 101-102, May 1950. (In German)

Neurofibroma involving the stomach is seldom reported in the literature. It is usually diagnosed by histologic examination after operation. It may be located in various situations and is observed on x-ray examination as a filling defect without characteristic indication of the type of lesion.

The author describes a case in a 17-year-old patient associated with general von Recklinghausen's disease. Clinical symptoms comprised pain in the upper abdomen, a measure of resistance but no definitely palpable mass, no evidence of bleeding and no occult blood in the

stool. On x-ray examination, a rather sharply defined defect 3.5 cm. in length was observed in the distal pylorus. Peristalsis did not pass through this region on the lesser curvature, and there was retrograde peristalsis on the greater curvature. There was no deformity of the duodenal cap. Operation was performed (Billroth's type), with removal of the lower two-thirds of the stomach. Biopsy revealed neurofibroma, with involvement of the neighboring lymph nodes.

Differentiation from a true malignant lesion of the stomach might be surmised in this case because of the pronounced broadening of the stomach proximal to the stenosis, smoothness of the outline, especially about the borders of the lesion, and the youth of the patient. The lack of irregularity in the pattern of the gastric mucosa in the stenosed portion and elongated narrow pattern of the defect would be regarded as evidence against an antral gastritis, which shows more gradual narrowing of outline.

[The author does not specify that a stomach defect associated with general von Recklinghausen's disease would naturally be considered as probable neurofibroma. An isolated lesion within the stomach would be impossible to diagnose by x-ray studies.—E.W.S.]

One roentgenogram. E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Prolapse of the Gastric Mucosa. Report of 22 Cases.** Henry G. Rudner. *South. M. J.* 43: 480-487, June 1950.

Rudner points out that prolapse of the gastric mucosa into the duodenum has come, within the last decade, to be recognized as a definite clinical entity. The incidence of prolapse severe enough to produce symptoms appears to be as high as that of gastric ulcer.

The various theories concerning the cause of the condition are briefly reviewed. Although divergent in many respects, they appear to agree on one common causative factor: gastric hyperperistalsis. The symptoms are often typical but not characteristic enough to differentiate their cause from other disorders of the stomach and duodenum. The differential diagnosis is primarily radiographic. The characteristic roentgen finding in a barium study is a mushroom-shaped defect within the duodenal bulb (as though a mushroom were growing from the antrum of the stomach into the bulb). The author points out the necessity, in many cases, of frequent roentgen study with careful fluoroscopy and multiple films of the duodenal bulb if all cases are to be found.

Conservative therapy is recommended in most cases. It consists of diet, sedation, antispasmodics, rest, psychotherapy, and removal of stimulation. Surgery is necessary in a few cases, particularly in those with severe pain, hemorrhage, or pyloric obstruction. There is no unanimity of opinion concerning the best surgical procedure.

Five case histories are given, illustrated with reproductions of roentgenograms, photographs of surgical specimens, and photomicrographs.

T. FREDERICK WEILAND, M.D.  
Jefferson Medical College

**Duodenum Inversum.** Vincent Sheehan and Colin Kelly. *Irish J. M. Sc.*, pp. 288-292, June 1950.

Duodenum inversum is a congenital anatomical variant in which the normal counterclockwise direction



of the duodenum is reversed. It is a rare anomaly. In one series of 20,000 gastro-intestinal x-ray studies the incidence was 0.07 per cent (Feldman and Morrison: *Am. J. M. Sc.* 200: 69, 1940. Abst. in *Radiology* 36: 640, 1941). Most anomalies of the intestine arise from errors of rotation of the mid-gut, which extends from the ampulla of Vater to the splenic flexure of the colon, so that the first part of the duodenum is rarely involved. Either an error of rotation, or displacement of the gut by abnormally situated neighboring organs such as pancreas, right kidney, transverse mesocolon, and portal vein, may cause duodenum inversum.

The anomaly may be found at any age and is more common in males. Symptoms usually arise from associated lesions, the most common of which is peptic ulcer. Stasis may occur as a direct result of the anomaly. Roentgenologic examination is the only method of arriving at a correct diagnosis. Four types are described: (1) inversion of the entire duodenum except for the bulb; (2 and 3) inversion beginning at or beyond the ampulla of Vater, with or without redundancy of the duodenal loop; (4) inversion of the duodenum with congenital non-rotation of the intestine. In this last type the entire duodenum is in the right side of the abdomen.

A case is presented. The patient was a 34-year-old male who had symptoms from an associated peptic ulcer which had perforated. He was successfully operated upon, and recovery was uneventful except for formation of a pseudo-pancreatic cyst which was drained and marsupialized.

Two roentgenograms; 12 diagrammatic drawings.

GABRIEL WHITEMAN, M.D.  
University of Louisville

**Duodenal Diverticula: Report of Two Cases.** John J. Greenler and Charles N. Curtis. *Arch. Surg.* 60: 1011-1020, May 1950.

Totaling five different series in the literature, the authors found 81 duodenal diverticula in 1,825 autopsies, or a percentage of 4.4. An incidence of 16.2 per cent was reported in one of the series, in which a special technic of injecting paraffin into the duodenum of the cadaver was used. The figures for roentgen examination are much lower, 312 diverticula, or 1.4 per cent, in 23,050 gastro-intestinal examinations constituting seven separate series. [The age range in the autopsied series and of the patients having gastro-intestinal examinations is not mentioned. Unless it was similar, the two would not be comparable.—S.F.T.]

The usual site of duodenal diverticula is the second portion of the duodenum, on the concave side, near the ampulla of Vater. Weintraub and Tuggle (*Radiology* 36: 297, 1941) in a series of 349 cases found that 231, or 66 per cent, arose from the inner border of the second portion.

The diverticula usually occur singly, but two or more may occur together. [They may also be bi- or trilobed.—S.F.T.] Two varieties are recognized: (1) the true diverticulum, containing all the duodenal layers in its wall, and (2) the false diverticulum, which is actually a herniation of the mucosa through the muscularis.

There is no typical symptom or group of symptoms indicative of duodenal diverticula. Probably 85 to 90 per cent are asymptomatic. The most common symptom is pain, usually dull and aching, in the right lower portion of the epigastrium. The only way of arriving at a diagnosis is by roentgen examination and this must

often be repeated because of the dynamic character of the lesion. Even if a diverticulum is discovered roentgenologically, this does not mean that it is responsible for any symptoms which may be present. A cholecystogram should be made and a complete gastro-intestinal examination done to rule out other disease. If another cause is found to explain the symptoms, such as peptic ulcer or disease of the gallbladder, the symptoms are probably not due to the diverticulum. If, however, residual pooling for three to six hours and tenderness over the diverticulum are found during the roentgen examination, it is much more likely that the given symptoms may be due to the diverticulum.

Of the various complications of duodenal diverticula, probably the most common is obstruction of the common bile duct and pancreatic duct due to pressure. Diverticulitis is another serious complication, favored by the paucity of muscular tissue in the sac and the fact that the ostia are often concealed among the plicae circulares of the duodenum. It is more commonly associated with the large false diverticulum with a narrow neck and poor emptying power.

Two unusual cases are presented. In Case I the common bile duct actually entered the apex of the diverticulum. The second patient gave a history of typical obstructive jaundice interpreted as due to malignant changes in the region of the pancreas. Even at operation the chronic inflammatory mass felt "carcinomatous" and for this reason a radical resection was done. Pathologic examination revealed a duodenal diverticulum lying within the substance of the pancreas, surrounded by dense fibrotic tissue producing obstruction to the common duct.

One cholangiogram; 1 diagram; 1 photomicrograph.  
S. F. THOMAS, M.D.  
Palo Alto, Calif.

**Achlorhydria and Duodenal Ulcer: A Report of Two Cases Having Achlorhydria and Diagnosed as Duodenal Ulcer Not Proven at Surgery.** A. J. Kauvar and Laban W. Leiter. *Gastroenterology* 15: 550-555, July 1950.

The validity of Schwartz's concept of "no acid—no ulcer" has been substantiated by a mass of evidence showing the importance of the acid-pepsin factor in the genesis of benign duodenal ulcer. From time to time case reports have appeared suggesting the coincidence of peptic ulcer and achlorhydria. This paper reports two cases showing a rather typical ulcer picture, both clinically and roentgenologically, but with persistent histamine-refractory achlorhydria. Had it not been for the fact that these cases were subjected to surgery, they might indeed have been classified as examples of duodenal ulcer in the presence of a true achlorhydria.

In the first case, two gastro-intestinal series were performed, four months apart, and in both instances duodenal ulcer was diagnosed. The patient was placed on medical management with relief of symptoms. Three successive gastric analyses after injection of histamine revealed a total acidity of 15 units, 34 units, and 28 units, respectively, with no free acid. Gastroscopic examination showed moderate atrophy of the gastric mucosa.

Since an active duodenal ulcer with achlorhydria is considered to be rarer than a duodenal cancer, an exploratory laparotomy was undertaken. The surgeon reported many "rather dense adhesions leading from a thick-walled, pale gallbladder across the duodenum and to the duodenum," producing a deformity demonstrable



by x-rays. There was no evidence of gastric or duodenal ulcer on direct observation or palpation. The gallbladder was removed and a pathological diagnosis of chronic cholecystitis made.

In the second case gastric analysis on three different occasions demonstrated absence of free acid even with use of histamine. The roentgenologist reported spasticity of the duodenal cap with a definite ulcer niche near the base. Cholecystograms showed a non-functioning gallbladder.

At operation the gallbladder was found to be filled with stones. Adhesions extended from the gallbladder to the duodenum, but there was no evidence of ulcer.

Two roentgenograms. **GEORGE G. REGNIER, M.D.**  
University of Arkansas

**Leiomyosarcoma of the Duodenum.** J. A. Heymann and Gordon G. Clark. *Am. J. Surg.* 80: 119-123, July 1950.

The sixteenth case of leiomyosarcoma of the duodenum is presented. A preponderance of cases occur from the fourth to the sixth decade of life; males are affected more often than females, in the ratio of 3:2. Symptoms resemble in a general way those of sarcoma of any other part of the small intestine, consisting chiefly of pain, loss of weight, weakness, and anemia. If the growth arises from the outer muscular layer, the tumor may become very large and may be palpated early; if it arises from the inner coat, there is usually early bleeding into the intestinal tract.

A brief review is given of the various theories as to the origin of these tumors.

Emphasis is placed on the importance of the x-ray examination in detecting lesions of the small bowel.

Treatment is surgical, either by local excision when the tumor is suitably situated or by pancreaticoduodenal resection when the ampulla is involved.

Five illustrations, including 2 roentgenograms.

**LUTHER JARVIS, M.D.**  
University of Pennsylvania

**Polyp of the First Portion of the Duodenum: Case Report.** Edwin W. Edwards and Gordon McHardy. *Gastroenterology* 15: 514-517, July 1950.

A polyp of the first portion of the duodenum is reported. It was apparent roentgenologically as a filling defect in the duodenal lumen just distal to the bulb. Roentgenology affords the only preoperative means of diagnosis of these benign duodenal tumors.

One roentgenogram; 1 photomicrograph; 1 table.

**Non-Malignant Duodeno-Colic Fistula. Report of Two Cases.** Heneage Ogilvie. *Ann. Surg.* 131: 899-902, June 1950.

Fistulas between the duodenum and colon are rare. Most of those reported have been due to the extension of a carcinoma of the transverse colon. Only 5 benign duodenocolic fistulas have been reported in the past sixty-five years. The cause was duodenal ulcer in three cases, typhoid ulceration in one, and ulcerative colitis in one. Two cases are reported here, in which the communication was between the third part of the duodenum and the ascending colon. In each case the fistula appeared to have originated in a caseating tuberculous lymph node.

Four roentgenograms. **EDSEL S. REED, M.D.**  
Louisville, Ky.

**Intussusception in Children and Adults. A Critical Review with the Addition of Thirty-eight New Cases.** José M. Ferrer, Jr. *S. Clin. North America* 30: 515-528, April 1950.

Intussusception is described as the most frequent and most important abdominal emergency encountered in infants from three to eleven months old. Very rarely, in this group, is it related to any demonstrable intestinal lesion. Of 13 cases, 1 was associated with a duplication of the ileum and 1 with a Meckel's diverticulum; in the other 11, no cause for the intussusception was found.

In older children and adults intussusception is almost invariably secondary to pre-existing disease. A list of nineteen primary lesions which produced intussusception in 22 patients over twelve years of age is presented.

The pathological picture is determined by compression of the mesenteric vessels. This produces edema of the bowel, followed by infiltration with leukocytes and erythrocytes; if the arterial blood supply is stopped, gangrene and perforation result. With complete ileus, mechanical or paralytic, progressive depletion of water and electrolytes occurs. Sodium and water are excreted by the kidney to combat alkalosis due to loss of chlorides; shock appears, and finally uremia and death.

The etiologic factors in infancy are undetermined. In older children and adults, polyps, Meckel's diverticulum, duplications, lipomas, and malignant tumors are the usual causes.

In infants, diagnosis is not difficult, because of the characteristic history of onset and physical signs. In older children and adults the picture is usually more complicated, due often to the signs and symptoms of the primary lesions. The four cardinal signs: intermittent abdominal cramps, vomiting, rectal bleeding, and a mass felt abdominally or rectally, are the same in children and adults. Dance's sign, a sensation of emptiness in palpating the right lower quadrant, is due to absence of cecum and terminal ileum from their normal position.

Roentgen examination is usually helpful. Three-position films demonstrate varying degrees of mechanical ileus. Dilated small loops with fluid levels are frequently seen. In colonic intussusception the proximal large bowel may be markedly distended. Early in the disease, none of these signs may be present; therefore, in suspected cases, barium enema studies, including fluoroscopy, should always be done. In a large majority of cases, the right side of the colon will be involved. The "coiled spring" appearance in the involved colon is caused by the barium insinuating itself between the intussusceptum and the intussusciptum. For intussusception in the small intestine, special roentgen techniques such as barium instillation through an indwelling Miller-Abbott tube are useful in demonstrating the lesion, but the authors feel that the delay in surgical treatment does not justify this type of procedure in most cases.

The surgical treatment is discussed in detail, as is non-operative management. The latter consists in an attempt to reduce the intussusception by means of a barium enema under fluoroscopic observation. Reduction is indicated by filling of the terminal ileum with barium, disappearance of the mass, subsidence of pain, improvement in the patient's general condition, and expulsion of a large amount of gas and feces with the barium. The principal danger of this method lies in non-recognition of an incompletely reduced ileo-ileal component. Mortality is low when symptoms have

been present only twenty-four hours or less. With delay in treatment mortality rates rise rapidly.

Six roentgenograms; 1 photograph.

ALTON S. HANSEN, M.D.  
Peoria, Ill.

**Acute Jejuno gastric Intussusception. Report of a Case.** T. Richard Watson, Jr., and Walter B. Crandell. *Surgery* 28: 116-120, July 1950.

Jejuno gastric intussusception is a definite entity which presents striking diagnostic features and may be recognized preoperatively. It is usually a late complication of gastro-enterostomy or gastrectomy, in which either or both of the jejunal limbs intussuscept through the stoma into the stomach.

According to the authors, the most important diagnostic features are: (1) previous gastric surgery; (2) persistent emesis, including hematemesis, suggesting both pyloric obstruction and bleeding ulcer; (3) constant mid-epigastric pain; (4) an epigastric mass; (5) an outline of small bowel mucosa within the stomach revealed roentgenographically following a barium swallow.

A case is reported which was diagnosed clinically, confirmed roentgenographically by demonstration of loops of small bowel within the stomach, and successfully treated.

Three roentgenograms.

MORTIMER R. CAMIEL, M.D.  
Brooklyn, N. Y.

**Acute Intestinal Obstruction.** Gustave A. Haggstrom and Louis M. Rousselot. *S. Clin. North America* 30: 479-494, April 1950.

The authors begin their paper with a lucid discussion of the pathologic physiology of acute intestinal obstruction. The violent peristalsis and the ensuing paralysis and distention when a sudden obstruction occurs initiate a series of local and systemic changes. Gangrene is delayed for a period by distention of the bowel, but as it persists there are decreased absorption and an increased fluid content; capillary permeability increases, and fluids are lost from the vascular bed into the tissue spaces of the bowel wall. The latter becomes edematous, and fluids pass into the lumen and in the later stages through the serosa into the peritoneal cavity. There is further loss of fluid and electrolytes from vomiting, and disturbances in acid-base balance result. The circulating blood volume is constricted; hyperproteinemia develops with a tendency to generalized edema, and dehydration and hemoconcentration further impair the efficiency of the circulation.

An etiologic classification of intestinal obstruction is presented, postoperative adhesions being shown to account for 38 per cent of 76 cases reviewed by the authors from St. Vincent's Hospital, New York.

The diagnostic signs and symptoms are reviewed and the importance of adequate roentgen examination is emphasized. Differentiation between small and large bowel obstruction can be made only by this means. When the ileocecal valve is competent, roentgenograms will reveal evidence of colon distention only, when the left colon is obstructed; if the valve is incompetent, both large and small bowel will show distention. Exclusively small intestinal distention almost surely places the offending lesion in that segment if due to mechanical causes, but this same picture may be seen in paralytic

ileus. Supine, semi-erect, and lateral decubitus films are made routinely.

Treatment of acute obstruction in the series of cases reported included use of the Miller-Abbott tube for suction decompression; hydration; in cases of closed loop obstruction, immediate operation; antibiotics and sulfonamides in standard doses.

Results are compared with those published from 1907 to 1932 (pre-tube decompression era). The current mortality of 19.7 per cent is still high, but in the earlier period it was 42 per cent.

Seventeen roentgenograms; 2 tables.

ALTON S. HANSEN, M.D.  
Peoria, Ill.

**Acute Intestinal Obstruction. Comparative Studies of Small Intestinal and Colic Obstruction.** Marshall L. Michel, Jr., Leonard Knapp, and Arthur Davidson. *Surgery* 28: 90-110, July 1950.

The authors believe that obstruction of the small intestine and of the large intestine differ in so many respects that they might better be discussed as two entirely different subjects.

The average age of patients with small intestinal obstruction is forty years, compared to fifty-one years for those with colon obstruction. Postoperative adhesions and hernias are the most common causes of small bowel obstruction, while carcinoma is responsible for the greatest number of obstructions of the large bowel.

With small bowel disease, there is an excessive loss of fluid into the lumen of the small intestine, producing severe chemical disturbances in the body tissues and fluids and resulting in dehydration, hypochloremia, alkalosis or acidosis. Disturbances of this type are not usually seen with large bowel obstruction.

Roentgenograms are frequently helpful in differentiating between small and large bowel obstruction. The radiologist should not be content with a non-specific diagnosis of "intestinal obstruction," but an effort should be made to identify the distended loops in order to localize the trouble. Scout films should be taken in the erect and supine positions in order to demonstrate the degree of distention and the presence of fluid levels. In the very earliest stages the distention may be so slight that serial studies, at intervals of one to several hours, are indicated. However, too great delay may be hazardous.

When there is a competent ileocecal valve and obstruction in the descending portion of the colon, as by a carcinoma, the roentgen picture may show distention limited entirely to the colon. Volvulus, the second largest cause of colon obstruction, may also manifest itself as a closed loop of distended colon. The conical termination of the gas column, or the barium column during an enema study, is typical.

The scout film may not be diagnostic when distention is severe. In such cases it may be difficult to determine whether a mechanical or paralytic ileus is present, or whether the obstruction is in the colon or the lower small intestine.

When intestinal obstruction is suspected, it is the opinion of the authors that barium enema studies may be helpful in many cases. This is not in agreement with some surgeons, who believe that in the acute case a barium enema is accompanied by danger of perforation of the colon. The authors have never encountered such a complication. On the other hand, it is emphasized that barium must never be given by mouth in any type

of acute intestinal obstruction, whether it is of the small or large bowel type.

A long discussion of treatment is included.

Thirteen illustrations, including 7 roentgenograms.

MORTIMER R. CAMIEL, M.D.  
Brooklyn, N. Y.

**Early Manifestations and Radiologic Indications of Small Bowel Obstruction.** Claude J. Hunt. South. M. J. 43: 469-474, June 1950.

The "tripod" of symptoms of small bowel obstruction, invariably present, consists of pain, visible peristalsis, and borborygmus. High obstruction produces early prostration, profuse emesis, dehydration, and severe upper colicky pain. Abdominal distention is minimal and there is great loss of fluids and electrolytes. Passage of gas or bowel evacuation may be present, even in complete bowel obstruction; these are reflex in nature and should not give a false sense of security as to bowel patency.

X-ray examination is the only means by which one can make an early diagnosis of small bowel obstruction and can determine quite accurately the type of obstruction present. It must be remembered that gas is normally present in the stomach and colon but in the small bowel is so emulsified with the liquid contents that, except in the newborn, it is not detectable on a plain abdominal film.

In simple obstruction the proximal bowel is distended. It assumes, coil by coil, a transverse relationship to the long axis of the body, and the valvulae conniventes can be seen. With this characteristic step-ladder pattern, it can be said with relative certainty that the blood supply is not in jeopardy and adequate time can be taken to intubate the intestines, decompress the bowel, and rehabilitate the patient physiologically, before operation is undertaken. This deferred elective operative treatment applies only to advanced conditions, as all early obstructions should be operated upon immediately.

On the other hand, if the distended loop of bowel assumes no definite pattern, if the distention is irregular, the bowel is darker, and the valvulae conniventes are not seen or are poorly visible, the obstruction is most likely of a strangulated type. In this instance, the blood supply is usually damaged and immediate operation is imperative.

The authors list the indications for the use of the Miller-Abbott tube in small bowel obstruction. In their practice, the procedure of passing the tube is the function of the radiologic department.

Five roentgenograms; 2 photographs.

T. FREDERICK WEILAND, M.D.  
Jefferson Medical College

**Congenital Atresia of the Small Intestine, with Report of Cases.** Lon Grove and Earl Rasmussen. Ann. Surg. 131: 869-878, June 1950.

The authors report a series of 15 cases of congenital atresia of the small intestine, 11 duodenal, 1 jejunal, and 3 ileal.

Serial roentgenograms of the gastro-intestinal tract in the normal child from birth showed that gas reaches the sigmoid and rectum within ten hours. The gas pattern in atresias of the duodenum and high jejunum was characteristic, showing absence of gas below the point of obstruction if there was complete atresia. In

complete atresia the picture was at times confusing; it may be simulated by malrotation and volvulus.

In low bowel obstruction, x-ray studies with contrast medium, usually barium, are often condemned, but the authors found them useful in suspected duodenal atresias, especially with stenosis, and encountered no harmful complications. In low bowel atresia, roentgenograms confirmed the degree of distention, but the site of obstruction was not so definitely located as in the patients with duodenal atresia.

The total mortality in the series was 40 per cent; the operative mortality 10 per cent. The surgical procedures are listed and preoperative and postoperative therapy are discussed.

Five roentgenograms; 2 diagrams; 2 tables.

EDSEL S. REED, M.D.  
Louisville, Ky.

**Diagnosis and Treatment of Volvulus of the Sigmoid Colon.** Darrell A. Campbell and R. Glenn Smith. S. Clin. North America 30: 603-611, April 1950.

The reported incidence of volvulus as a cause of large bowel obstruction varies widely. The authors found 13 examples among 296 cases of intestinal obstruction of all types seen at the Wayne County General Hospital (Eloise, Mich.) in ten years. The causative factors include congenital increase in the length of the sigmoid and its mesentery together with narrowing of the mesenteric attachment, the aging process, a coarse rough diet, and adhesive bands. The diagnosis is based upon the usual signs of large bowel obstruction, plus a history of recurrent attacks (in 50 per cent of the cases), pain in the left lower quadrant, no feces or gas escaping from the rectum, no vomiting or fever unless complications are present, abdominal distention frequently with a discernible loop filling the left lower quadrant, an empty rectum, and obstruction on attempts to pass the sigmoidoscope.

Roentgen findings include a large single loop of bowel rising out of the pelvis; greater distention of this loop than of other distended loops which may be present; absence of fluid levels in patients who have not had enemas; loss of haustral markings; increased thickness of flexion creases. Usually supine and erect anteroposterior films suffice. Barium examination is usually conclusive, showing the so-called "bird's beak" deformity.

Therapeutic measures include gentle attempts to reduce the volvulus, celiotomy, and eventual sigmoidectomy. Attempts to fix the bowel after the volvulus has been reduced have seldom been successful. The indications are for (a) resection with primary anastomosis in interval cases, and in those which have been reduced without operation; (b) obstructive resection in cases with gangrene; (c) exteriorization of the loop in cases where celiotomy is required for detorsion and where the loop is not gangrenous, followed after five to ten days by resection and primary anastomosis.

Six illustrations, including 4 roentgenograms, and 1 table.

ALTON S. HANSEN, M.D.  
Peoria, Ill.

**Rupture of the Bowel in the Newborn Infant, Including a Case Report of Rupture in the Large Intestine with Recovery.** C. Marshall Lee, Jr., and Bruce G. MacMillan. Surgery 28: 48-66, July 1950.

When bowel rupture occurs in a newborn infant there is usually an associated obstruction. The two most

common causes of obstruction leading to perforation are atresia and meconium ileus. If a preoperative differential diagnosis cannot be made, the surgeon should be prepared for either.

Congenital atresia represents a complete obstruction caused either by a diaphragm of intrinsic bowel tissue or by a string-like segment of bowel with no lumen. The obstruction derives from a failure of recanalization of the bowel after it has gone through a solid phase during the fifth to tenth week of fetal life. The presence of a perforation strongly suggests that obstruction is complete. Perforation is seldom found with stenosis, as differentiated from complete atresia.

Meconium ileus is related to fibrocystic disease of the pancreas, which is a part of a systemic disorder variously affecting the secretory cells and ducts of the pancreas, salivary glands, liver, and the tracheal and bronchial lymph nodes. Impaired secretion of pancreatic enzymes results in improper digestion of meconium. The meconium becomes so thick that it will not pass through the intestinal tract, but becomes impacted and may produce complete obstruction, usually in the ileum. If the pancreatic disease does not appear until after the neonatal period, the picture is that of the celiac syndrome.

The roentgenologic findings of perforation of the bowel in the newborn are said to be characteristic. The flat film shows massive pneumoperitoneum and diffuse distention of the bowel. This is usually sufficient for diagnosis of rupture, and when perforation is suspected, barium studies are contraindicated. A barium enema may be helpful in suspected cases of atresia or meconium ileus without perforation, since the tiny, undistended colon is thought to be diagnostic of complete obstruction higher up, whether or not the barium can be made to reach the point of obstruction. A diagnosis of microcolon should not be made mistakenly. Upper gastro-intestinal series are more dangerous, since the vomiting infant may inspire the barium.

A case is presented of perforation of the cecum due to congenital atresia of the large bowel near the splenic flexure. The rupture in this case was at first attributed to obstetrical trauma and the perforation was repaired. Distention recurred, however, and a barium enema study disclosed the atresia.

Eight figures, including 7 roentgenograms.

MORTIMER R. CAMIEL, M.D.  
Brooklyn, N. Y.

**Localized Paralytic Ileus: An Early Roentgen Sign in Acute Pancreatitis.** Aaron I. Grollman, Sander Goodman, and Archie Fine. *Surg., Gynec. & Obst.* 91: 65-70, July 1950.

The authors have observed the presence of an isolated, gas-distended loop of small intestine on a survey film of the abdomen in acute pancreatitis and report 8 cases in which it was demonstrated. It does not occur in all instances of the disease. The loop is usually seen in the left upper quadrant but also occurs in other regions. It is believed to represent a localized paralytic ileus due to escaping pancreatic enzymes coming in contact with a segment of the jejunum or ileum, as postulated by Metheny *et al.* (*Surg., Gynec. & Obst.* 79: 504, 1944. *Abst. in Radiology* 45: 204, 1945).

A similarly distended loop is encountered in cases of acute appendicitis and acute cholecystitis and has been called the "sentinel loop" (Levitin: *Radiology* 47: 10, 1946). It is a common early occurrence, also, in acute

mechanical obstruction. Its demonstration calls for a serum amylase determination to confirm or exclude a diagnosis of pancreatitis.

Nine roentgenograms JOHN M. PHILLIPS, M.D.  
University of Pennsylvania

**Pancreatic Abscess. Its Radiological Features.** Eric Samuel. *South African M. J.* 24: 420-422, June 3, 1950.

Pancreatic abscess is rarely diagnosed radiologically, since it can be recognized only when it contains gas. Otherwise it is indistinguishable from a pancreatic cyst. In the presence of gas in the abscess cavity, a fluid level lying behind the stomach in the lesser sac can be seen with the patient in the erect position. Lateral films show the stomach displaced forward and stretched around the abscess cavity. An infected pancreatic cyst presents an identical picture.

Other conditions giving rise to a fluid level in the left hypochondrium and therefore calling for differentiation are: an obstructed loop of bowel, diverticula, especially around the duodenojejunal flexure; internal hernia into the paraduodenal fossa.

The author found only four reports of pancreatic abscess showing gas formation and a fluid level on the roentgenogram, and to these he adds a fifth.

Three roentgenograms. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Annular Pancreas: Report of a Surgical Case with a Two Year Followup.** Joel W. Baker and Morton C. Wilhelm. *Gastroenterology* 15: 545-549, July 1950.

The occurrence of annular pancreas creating duodenal obstruction is seen only occasionally. Of a total of 53 reported cases only 14 have been treated surgically, and only 1 of these was diagnosed preoperatively. The majority were incidental autopsy findings with no history of symptoms attributable to the condition. [A second case with a preoperative diagnosis is reported in *Radiology* 55: 859, 1950.—Ed.] The case reported here is the fifteenth [sixteenth] surgical case and the third with associated gastric ulcer. It has been said that "corroborative evidence of obstruction when combined with a smooth niche constricting the second portion of the duodenum from its dextral aspect should make possible the diagnosis." In this particular case, the constriction was symmetrically annular rather than dextral.

The patient was a 59-year-old white male who had had upper abdominal pain for two months, occurring in severe attacks every two to three weeks. Abdominal examination was negative and gastric analysis revealed 27 degrees free acid and 30 degrees total acid. A gastro-intestinal series showed a markedly enlarged duodenal bulb with circular narrowing of the second portion of the duodenum, and delayed emptying of the stomach and duodenal bulb. At operation for chronic duodenal obstruction of undetermined etiology, a markedly dilated duodenal bulb due to an annular pancreas and a benign gastric ulcer 1 cm. in diameter situated on the mid-lesser curvature were found. A subtotal gastric resection with an anterior gastrojejunostomy was performed and, in addition, a duodenojejunostomy was done to protect the dilated duodenal bulb against perforation. Two years postoperatively the patient was asymptomatic with the exception of some discomfort after a large meal.

In cases of this type, a duodenojejunostomy is the



procedure of choice, since division of the pancreatic ring is attended by numerous complications.

Two roentgenograms; 1 drawing.

GEORGE G. REGNIER, M.D.  
University of Arkansas

**Value of Laminography in the Difficult Gallbladder Problem.** George Levene and Charles B. Perkins. *Am. J. Digest. Dig.* 17: 240-242, July 1950.

The roentgen diagnosis of gallbladder disease is highly accurate where positive findings are shown, but it is sometimes difficult or impossible to make a positive diagnosis of stones where the gallbladder is poorly visualized. Numerous technics have been suggested for the better visualization of stones. Films taken in the erect position, in right lateral decubitus, in inspiration and expiration, and after the administration of prostigmin and other drugs may help to distinguish calculi from confusing gas shadows.

Another aid in making a positive diagnosis of gallstones is the laminagraph. The patient is placed in the prone position and is immobilized by a balloon with a compression band. The depth at which the laminagrams are to be made is determined when the patient is on the table. If, for example, the center of interest is estimated to be 6 cm. from the table top, three films are taken at 4, 6, and 8 cm. depth. If, upon examination of these, a suspicious area is encountered, more films are obtained 1 cm. above and 1 cm. below the area in question.

Three cases are described where a positive diagnosis of stones was made by laminagraphy when the findings were not clear by conventional films.

Six roentgenograms. JOSEPH T. DANZER, M.D.  
Oil City, Penna.

**Technic, Indications and Value of Postoperative Cholangiography.** N. Frederick Hicken, A. James McAllister, Bruce Franz, and Earl Crowder. *Arch. Surg.* 60: 1102-1113, June 1950.

Postoperative cholangiography is the science of visualizing the extrahepatic biliary tract by means of contrast roentgenography. This is accomplished by introducing diodrast into drainage tubes which have been placed in the gallbladder or bile ducts. This study comprises an analysis of 750 postoperative cholangiograms.

Postoperative cholangiograms are usually made from the fifth to the eighth postoperative day. The authors employ the gravity method. A small glass funnel is connected to the T tube, and the top of the funnel is held about 6 inches above the level of the anterior abdominal wall. An isotonic solution of sodium chloride is first introduced, which perfuses through the ductal system, displacing air and flushing out sediment which might be lodged in the drainage system. About 20 c.c. of diodrast is then permitted to flow through the ductal tract, and when the patient complains of a little epigastric discomfort, the roentgenogram is taken. It is important that roentgenograms be taken immediately after the introduction of the diodrast, as any delay may permit contrast medium to escape into the duodenum, in which event the empty bile ducts are not visualized.

If the first cholangiogram should demonstrate an obstruction of the common bile duct, then serial roentgenograms are taken at ten-minute intervals. In many

instances a spastic contraction of the sphincter of Oddi obstructs the ampullary orifice so effectively that none of the opaque medium will be able to pass into the duodenal lumen. If a second roentgenogram is taken ten minutes later, the dyssynergic spasm will have relaxed so that the diodrast can flow uninterruptedly into the intestinal tract. Differentiation between calculous and muscular obstruction of the ampullary orifice can be made by placing a tablet of nitroglycerin under the patient's tongue and taking a cholangiogram three minutes later. This vasodilating drug causes the sphincteric spasms to disappear, but true organic obstructions are unaffected.

Air bubbles may closely simulate calculi. When the common duct harbors a "shadow" which is thought to be an air bubble, serial cholangiograms are made with the patient in various positions. A "shifting shadow" is pathognomonic of entrapped air. The authors have found repeated studies on successive days of value; if the intraductal defect does not appear on all the roentgenograms, it can safely be attributed to entrapped air.

Postoperative cholangiograms provide an accurate method of visualizing the obstructions which are responsible for external biliary fistulas and of determining the size, number and position of "overlooked choledochal stones." One hundred patients who had undergone choledocholithotomies were studied, and 12 per cent were found to have "elusive stones" remaining in the common duct after the primary operation.

Postoperative cholangiograms are invaluable, also, in determining when an obstructive pancreatitis has subsided. The swollen pancreas exerts a concentric compression on the terminal portion of the choledochus, obstructing its ampullary orifice and often initiating a severe cholemia. When the roentgenograms demonstrate that the diodrast, which has been injected into the drainage tubes, is able to pass uninterruptedly through the ampullary orifice into the duodenum, it is safe to assume that the pancreatic obstruction has disappeared, and the drainage tube can be removed. In a group of 30 patients the pancreatitis was found to have subsided by the eighth postoperative day, and the decompressive catheters could be removed.

Five cholangiograms. DANIEL WILNER, M.D.  
Atlantic City, N. J.

**Immediate Cholangiography. Indications, Technic and Illustrative Cases.** R. Franklin Carter and Lee Gillette. *J. A. M. A.* 143: 951-954, July 15, 1950.

Direct injection of opaque solutions into the exposed common duct is a reliable procedure worthy of much wider usage. It is especially indicated (1) in suspected congenital obstructions of the biliary duct, (2) whenever the indications for exploration of the common duct are vague or uncertain, and (3) in all secondary operations on the biliary tract for stricture of any part of the bile ducts or for suspected stones in the common duct. Injection into the gallbladder is not recommended, since narrowing of the cystic duct may prevent the contrast material from reaching the common duct. Three cases are reported.

[With cholangiography, strictures, stones, and anomalies are readily detected, eliminating the necessity for repeated probing and possible re-operation. It seems much more logical to do cholangiography immediately than as a delayed procedure, since pathological findings on a delayed examination mean that re-operations



tion is necessary. An important by-product of the procedure is the peace of mind afforded the surgeon.—Z.F.E.]

Two roentgenograms; 2 drawings.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**A Case of Radio-Opaque Bile without Cholecystography.** V. Berman and J. J. Skapinker. *South African M. J.* 24: 494-495, June 24, 1950.

A case is reported in which plain films showed the gallbladder to be well filled with dense bile and apparently containing numerous small to moderate-sized non-opaque stones. A second examination, with the administration of dye, showed a similar picture. Between examination and surgery, two weeks later, the patient was given a powder (by another doctor) which was supposed to cause the stones to pass. At operation no stones were found; the gallbladder was chronically inflamed and contained a thick, green, gelatinous bile which was discarded before chemical studies could be done. The opacity of the bile is believed to have been due to a high calcium content.

Two roentgenograms. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

## RETROPERITONEAL TUMORS

**Primary Retroperitoneal Tumors. A Summation of Thirty-three Cases.** Harry R. Newman and Bernard D. Pinck. *Arch. Surg.* 60: 879-896, May 1950.

For purposes of general consideration, primary neoplasms of the retroperitoneal space may be classified in the following manner:

### I. Cystic tumors

- (a) Dermoid
- (b) Teratoid
- (c) Developed from wolffian body
- (d) Developed from müllerian duct
- (e) Lymphatic
- (f) Traumatic
- (g) Parasitic

### II. Solid tumors

- (a) Benign
  1. Lipoma
  2. Fibroma
  3. Leiomyoma
  4. Lymphangioma
- (b) Malignant
  1. Liposarcoma
  2. Myosarcoma
  3. Fibrosarcoma
  4. Neurosarcoma
  5. Lymphosarcoma
  6. Hodgkin's disease
  7. Carcinoma
  8. Undifferentiated sarcoma
- (c) Undifferentiated tumors

Retroperitoneal tumors afflict either sex at any age, though the preponderance of cases occur in the fourth to the sixth decade. The onset of subjective symptoms is usually insidious. They may be preceded by the observation of a mass. The diagnosis is made with difficulty and largely by the process of exclusion. The principal abdominal masses to be considered in the differential diagnosis are as follows:

### A. Diseases of the kidney producing a mass

1. Hydronephrosis
2. Polycystic disease of the kidney
3. Solitary cyst
4. Hypernephroma
5. Perirenal abscess
6. Solitary cyst of the kidney

### B. Intra-abdominal masses

1. Neoplasm and cysts of liver
2. Enlargement of spleen
3. Tumors of ovary
4. Cysts of omentum and mesentery
5. Cysts of pancreas
6. Tumors of gastro-intestinal tract
7. Urachal cysts

The gastro-intestinal roentgenogram not only eliminates from diagnostic consideration a primary mass in the digestive tract but may clearly demonstrate displacement and distortion of the bowel referable to a retroperitoneal tumor. Pycelography, with exposures in a variety of positions, is the keynote to diagnosis, and the characteristic evidences of extrinsic pressure on the urinary tract are so frequently pathognomonic of retroperitoneal tumor as to confirm a suggestive impression. Typical urographic defects are lateral, mesial, or anterior deflection of the ureter, compression distortion of the pelvis and calices, renal rotation, obscuration of psoas shadows, and inexplicable density in the lumbar zone.

While surgical extirpation is the treatment of choice, a high percentage of the tumors have been shown to be radiosensitive, and "evidence from all clinics supports the impression that relief of subjective symptoms and prolongation of life can be extended by radiotherapy."

In the authors' own series of 33 cases, 68 per cent of the tumors were of sufficient size to be of diagnostic significance. "Careful retrospective scrutiny" indicated the presence of diagnostic roentgenographic changes in 53 per cent of the series. All the patients were explored, but in only 12 cases was the tumor considered operable and total excision surgically effected. A correct preoperative diagnosis was made in only 37 per cent of the series.

Three roentgenograms; 5 photomicrographs; 2 tables.  
S. F. THOMAS, M.D.  
Palo Alto, Calif.

## HERNIA

**Anterior Diaphragmatic Hernia.** Aristide Rollandi. *Radiol. med. (Milan)* 36: 468-478, June 1950. (In Italian)

Two cases of anterior diaphragmatic hernia are reported. This type of hernia usually occurs between the sternal and costal attachments of the anterior margin of the diaphragm through a potential space called the space of Morgagni or space of Larrey. From the study of his own cases and from a review of the literature, the author presents the following conclusions:

1. The anterior type of diaphragmatic hernia is very rare.
2. This type of hernia usually is of congenital origin.
3. The contents of the hernia usually include the omentum and the transverse colon, only exceptionally the stomach, cecum, or terminal ileum.
4. The anterior diaphragmatic hernia is usually contained within a sac.

5. While the clinical diagnosis is practically impossible because symptoms are confusing or absent, the radiological diagnosis is easy when the sac contains gas-filled viscera.
6. The radiological diagnosis of anterior diaphragmatic hernias which contain only omentum can be made by means of pneumoperitoneum.
7. The treatment of anterior diaphragmatic hernia is surgical and should be undertaken even in those cases which have no symptoms, because of the possibility of incarceration.

Nine roentgenograms. CESARE GIANTURCO, M.D.  
Urbana, Ill.

**Incidence of Hiatus Hernia in Patients Without Symptoms.** Irving B. Brick and Harold I. Amory. *Arch. Surg.* 60: 1045-1050, June 1950.

Three hundred ambulatory patients over the age of fifty, without significant gastro-intestinal symptoms, were examined roentgenologically for hiatus hernia. Each patient was studied (1) in the supine position and (2) in the Trendelenburg position with both legs raised without bending knees, a maneuver which is believed to increase the intra-abdominal pressure without affecting the intrathoracic pressure materially, as does the Valsalva maneuver.

Only 4 patients, or 1.3 per cent, were found to have a hiatus hernia. Since the incidence of hiatus hernia in series of cases with symptoms is much higher, it is suggested that the presence of this lesion may be significant in explaining the symptoms.

One table.

DANIEL WILNER, M.D.  
Atlantic City, N. J.

#### THE MUSCULOSKELETAL SYSTEM

**The Estimation of Fetal Maturity by Roentgen Studies of Osseous Development. Preliminary Report.** Amos Christie, Margaret Martin, Edwin L. Williams, Granville Hudson, and James C. Lanier, Jr. *Am. J. Obst. & Gynec.* 60: 133-139, July 1950.

The authors developed a suitable technic for visualizing fetal parts and studied the long bones of 100 fetuses *in utero* for osseous development. An anteroposterior and a right anterior oblique exposure of the abdomen were made on 14 X 17-inch films. If the desired areas cannot be visualized, a left anterior oblique and a lateral view are also obtained.

The following items were recorded from the roentgenograms, without reference to the case history: (1) presence or absence of the distal epiphysis of the femur and of the proximal epiphysis of the tibia; (2) estimated weight of the fetus; (3) estimated number of weeks of gestation.

Then, as a basis for evaluation, the following information was taken from the histories of the mother and baby: (1) weeks of gestation at the time of the roentgenogram as calculated from the menstrual history; (2) weight and length at birth; (3) any statement about the physical maturity of the infant at birth.

Unfortunately, none of the latter offer a completely satisfactory measure of fetal maturity at the time of the roentgenogram. The fetal weight at the time of roentgenography was estimated from the birth weight by deducting from the latter an amount equal to the estimated average gain in weight during the interval between the taking of the roentgenogram and delivery. As weight gains vary considerably as reported by vari-

ous observers, the authors used an average of two authorities: 21 gm., 26 gm., and 30 gm., respectively, for the eighth, ninth, and tenth lunar month. There is much better agreement in the reported gains in length during the fetal period, most authors reporting a gain of about 5 cm. per lunar month, and this estimate was used.

It was found that the average weight increased with the number of ossification centers present; on the average, female infants weighed less than male infants in the same group. If the maturity of the fetus were determined from the presence or absence of the centers for the distal femur and proximal tibia, an appreciable error resulted in about 10 per cent of the cases when both centers were either present or absent, and in about 20 per cent of the cases when only the distal femoral epiphysis was present.

In 76 per cent of the cases studied, the roentgenographic estimate of weight differed by less than 500 grams from the actual birth weight estimate, and in 92 per cent of the cases studied the difference fell within 750 grams.

These results demonstrate that, barring a minimum of failures due to imperfections in the roentgenograms or individual variability, estimates of fetal maturity *in utero* can be made with reasonable accuracy.

One chart; 3 tables. ROBERT H. LEAMING, M.D.  
Jefferson Medical College

**Genetic Chart in Marble Bone Disease with Dominant Polyphane Heredity.** Umberto Cocchi. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 73: 77-86, May 1950. (In German)

During the past forty-five years about 100 cases of marble bone disease have been diagnosed. Originally cases were grouped according to their hereditary tendency into three classifications: (1) malignant type of osteosclerosis with brittle bones and anemia, with a life expectancy of a few months to a few years; (2) osteosclerosis with brittle bones but no anemia; (3) benign osteosclerosis without brittle bones. Types 1 and 2 were regarded as recessive, 3 as a dominant hereditary factor.

In 1944, Schinz enlarged this classification and designated four types according to their characteristics and hereditary proclivities:

1. Simple dominant "monophane" heredity with mild course, presenting the picture of exclusive osteosclerosis and good prognosis.
2. Simple dominant "polyphane" heredity with an initially benign course and later severe anemia, with marked variations within the group.
3. Simple recessive "polyphane" heredity with short course and hopeless prognosis.
4. Simple recessive "monophane" heredity with mild course and relatively good prognosis.

The author presents a genetic chart, including 5 generations of a family and 91 individuals showing disease of Type 2, 10 of whom were studied radiologically. This chart was partially constructed twenty-three years ago by another observer and at that time the condition was considered as showing simple recessive characteristics. Completion of the chart definitely indicates a dominant hereditary factor. There is, however, a very marked variation within the individual members of the group under consideration, which leads to con-

fusion until the genetic chart is worked out through several generations.

[It may be suggested that we interpret monophane as "monophasic," indicating the single feature of general sclerotic changes throughout the skeleton; polyphane as "polyphasic," indicating in addition anemia, optic atrophy, deafness, etc.—E.W.S.]

Twelve roentgenograms; 1 genetic table.

E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Pseudocystic Disease of Bone.** W. E. Jacobson.  
Arch. Int. Med. 86: 35-50, July 1950.

The author suggests "pseudocystic disease of bone" as a suitable generic term to include a group of skeletal diseases of unknown causation whose differential diagnosis presents a difficult and complex problem, namely, Letterer-Siwe disease, Hand-Christian syndrome, eosinophilic granulomatosis and lipid granulomatosis (which according to Green and Farber—J. Bone & Joint Surg. 24: 499, 1942, abst. in Radiology 40: 107, 1943—appear to be various stages of the same basic lesion), and fibrous dysplasia, whose clinical features may be indistinguishable from these.

Roentgenologically, all the lesions in this group of diseases are characterized by what appear to be bone cysts, single or multiple. Histologically, the lesions are not true cysts but would seem to be proliferative processes of the reticulo-endothelial system.

Pertinent references are made to the literature and four cases are reviewed illustrating certain similarities among the above mentioned processes. Clinically and roentgenologically the conditions may be indistinguishable. Histologically they are dynamically related as shown in the following table.

PREDOMINANT HISTOLOGIC PICTURE	CURRENT TERMINOLOGY
Eosinophil	Eosinophilic granulomatosis
↓	Solitary eosinophilic granuloma
Large mononuclear cell or histiocyte	Histiocytosis
↓	Letterer-Siwe disease
Xanthoma or foam cell	Solitary xanthoma of bone
↓	Lipoid granulomatosis
Fibrous tissue	Hand-Christian syndrome
↓	Osteitis fibrosa disseminata
↓	Fibrous dysplasia of bone
Cartilage or bone	Albright's syndrome
	Some cases of dyschondroplasia(?)

Seven roentgenograms; 3 photomicrographs; 2 tables.

HARRY J. PERLBERG, JR., M.D.  
New York, N. Y.

**A New Case of Engelmann's Disease. Contribution to the Knowledge of Congenital Osteodystrophy.** Vladimir Gvozdanović. Fortschr. a. d. Geb. d. Röntgenstrahlen 73: 86-89, May 1950. (In German)

Engelmann first described the extremely rare condition which bears his name in 1929 and no further examples were published until 1948 (Sear: Brit. J. Radiol.

21: 236, 1948. Abst. in Radiology 52: 608, 1949). Only 8 cases have appeared in the literature.

All of the published cases followed the same general pattern, with dense sclerotic changes involving the diaphyses, homogeneous increase in bone density, and broadening of the shaft due to cortical thickening and subperiosteal new bone formation. Involvement was symmetrical, including all of the long bones, with similar changes in the skull, particularly the base and orbital and frontal regions. The epiphyses and metaphyses were not involved. There was relative increase in the length of extremities in proportion to the development of the bones of the trunk. Engelmann's original descriptive term was *osteopathia hyperostotica (sclerotisans) multiplex infantilis*. Neuhauser et al. (Radiology 51: 11, 1948) described the same condition under the name "progressive diaphyseal dysplasia."

Clinically the patients show anemia, more or less muscle atrophy, pain on movement, and retardation in growth. Mental development is not retarded. Differentiation from Albers-Schönberg disease, Caffey's disease (infantile cortical hyperostosis), the various types of fibrous dysplasia, especially polyostotic, and Paget's disease lies in the fact that bones are involved symmetrically, metaphyses and epiphyses are not affected, the jaw is not affected, and the condition often is recognized at an early age. The fact that the case reported here was diagnosed in a three-months-old child lends strong support to the theory that this rare osseous dysplasia is congenital in origin.

Four roentgenograms. E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Postinfantile Cortical Hyperostosis with Subdural Hematoma. Report of Case and Review of the Literature.** Bedford H. Berrey. Pediatrics 6: 78-85, July 1950.

A case of postinfantile cortical hyperostosis associated with a subdural hematoma in a 29-month-old girl is reported. The patient had been receiving approximately 37,500 I. U. of vitamin A daily. One of her first symptoms was hyperirritability about the arms. Mild photophobia, pseudoparesis of the right arm, and seboreic plaques over the right shoulder and thighs were noted. The hair was dry and coarse. There was a low-grade fever. Swelling was present from the orbital ridge of the zygoma posteriorly to the temporomandibular joint on each side. Movement of the right arm caused pain, and there was tenderness over the prominent right clavicle. Both feet were tender and swollen. Roentgenograms revealed periosteal thickening and fusiform calcification along the distal portion of the right ulna, both clavicles, the inferior margin of the right 7th rib, and the shaft of the 5th metatarsal. Trephination of the skull on the right side revealed a pulsating, thinly encapsulated blood clot beneath the dura. Within two weeks all symptoms and signs noted on admission had subsided except for equivocal tenderness over the right clavicle and a questionable disinclination to walk.

Two-thirds of reported examples of infantile cortical hyperostosis have occurred in males. Evidence of the syndrome appeared before the fifth month of life in 24 of the 32 cases previously reported; onset in the remaining patients, 4 of whom had received recognizably large doses of vitamin A, was between fourteen and thirty-six months. The cause of the infantile form is unknown. Recently hypervitaminosis has been sug-

gested as an etiologic possibility in postinfantile forms of the syndrome.

Bony lesions in younger and older age groups are radiologically similar. These consist of cortical thickening, in many instances lamellated, involving the mandible, scapula, clavicles, ribs, humerus, tibia and ulna, and occasionally the fibula, radius, metatarsals, and calvarium. The metaphyses of tubular bones are unaffected and the spongiosa, epiphyses, epiphyseal plates, and ossification centers are normal. Thickening of the pleura may be coincident with involvement of the ribs. Involvement of the mandible has not been reported in the older age group; lesions affecting the bones of the feet are perhaps more common.

Six roentgenograms.

HOWARD L. STEINBACH, M.D.  
University of California

**Ehlers-Danlos Syndrome.** Joseph T. Freeman. *Am. J. Dis. Child.* 79: 1049-1056, June 1950.

The general pattern of Ehlers-Danlos syndrome consists of excessive elastic skin, exceedingly lax joints, abnormally fragile skin and blood vessels, and a tendency to the formation of pseudomolluscous tumors at the site of trauma and of subcutaneous nodules which may manifest necrosis and calcium deposition. The syndrome is often associated with other congenital defects. In the case recorded here, in a girl of 13, roentgenograms of the hands showed a bilateral shortening and lack of development of the proximal phalanx of the fifth finger and there was clinical and roentgen evidence of an interauricular septal defect.

Two roentgenograms; 3 photographs; 5 photomicrographs.

HUGH A. O'NEILL, M.D.  
Cleveland, Ohio

**Result of Myelographies with Water Soluble Media.** Carl-Erik Johanson. *Acta chir. Scandinav.* 99: 560-567, 1950.

Since 1945, myelography at the Surgical University Clinics at Helsingfors has been carried out with 20 per cent abrodil or corresponding water-soluble agents. Changes indicating disk herniation were found in 146 of 204 patients examined. In 56 per cent of the 146 cases the findings indicated herniation between the fourth and fifth lumbar vertebrae and in 36.3 per cent between the fifth lumbar and first sacral segments. In 111 cases surgical exploration was done, showing the radiologic localization to be incorrect in 9. Five of the errors were due to lateral prolapses and 2 were in patients who had a transitional vertebra.

Seven tables.  
HOWARD L. STEINBACH, M.D.  
University of California

**Arthrography of the Shoulder Joint.** A. W. Lipmann Kessel. *Proc. Roy. Soc. Med.* 43: 418-420, June 1950.

This short paper is based on 25 arthrographic examinations of the shoulder joint and is preliminary to a full report before the Sixth International Radiological Congress by Dr. D. H. Nelson. The author is not enthusiastic about the usefulness of arthrography as a routine procedure, though he believes it will prove helpful after the technics have become standardized. Occasional unpleasant reactions are encountered.

Eight to 10 c.c. of 35 per cent pyelosil is used. The needle is introduced under local anesthesia into the joint space one inch anteriorly to the acromioclavicular

joint, and injections are done under fluoroscopic control. Failures were encountered due to the use of a needle with too long a bevel, resulting in injection into the bursa and soft tissues. The author prefers a child's lumbar puncture needle. Six different views are made following injection of the contrast material.

Examples of subacromial traumatic bursitis, "frozen shoulder," and rupture of the supraspinatus tendon are illustrated.

Six roentgenograms; 1 drawing.

J. DUDLEY KING, M.D.  
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**Supracondyloid Process of the Humerus.** C. M. Witt. *J. Missouri M. A.* 47: 444-446, June 1950.

The supracondylar process is an anomalous bony spur which extends downward and anteriorly from the medial aspect of the lower third of the humerus in approximately 1 per cent of all people of European ancestry. The bone spur may measure up to 2 cm. in length, and usually originates about 5 cm. above the medial epicondyle. In most cases it is joined by a fibrous band which extends downward from its tip to the medial epicondyle. Through the fibrocalfic foramen thus formed the median nerve usually passes, often accompanied by the brachial artery and, occasionally, the radial or ulnar artery. From this bridge the pronator teres muscle often arises, and the coracobrachialis muscle may infrequently insert here. The bone spur must be differentiated from bony tumors such as osteoma and osteochondroma.

Fractures of the process are uncommon, but have been reported. They respond to either conservative or radical (excision) therapy. The relationship of the supracondyloid process with the median nerve sometimes gives rise to symptoms of median nerve injury, which can be relieved by excision of the process.

The author presents 2 cases, one of which required operation, following which the patient was completely relieved of local pain.

Two roentgenograms; 1 diagram.

HUGH A. O'NEILL, M.D.  
Cleveland, Ohio

**Larsen-Johansson Disease of the Patella. Seven New Case Records. Its Relationship to Other Forms of Osteochondritis. Use of Male Sex Hormones as a New Form of Treatment.** J. Wolf. *Brit. J. Radiol.* 23: 335-347, June 1950.

Larsen-Johansson disease is an epiphysitis of an accessory ossification center at the distal aspect of the patella—an osteochondritis of the Osgood-Schlatter-Köhler type in one of its rarest forms. The history of the disease and its many synonyms are thoroughly reviewed. It is usually seen between the ages of ten and fourteen, and is slightly more common in males. Many theories have been advanced as to the cause. The commonest etiologic factors are repeated mild strains or trauma, endocrine disturbances, and an hereditary disposition. The author believes that the endocrine factor is probably of more significance than has hitherto been believed.

The symptoms are limp, pain, tenderness, and thickening of the tissues. The roentgen appearance in one of the author's cases is described as typical. The tibial tuberosity showed a mild degree of beaking, with slight osteoporosis but normal bone trabeculae. There



was incomplete fusion with the tibial diaphysis. The contour of the lower pole of the patella was irregular in outline, with a zone of rarefaction, and a little distally was a small, detached, almost round bony fragment not fused with the main patellar body, the line of separation running horizontally. Osgood-Schlatter's disease of the tibial tubercle is often associated. The condition is frequently bilateral.

Simple rest and immobilization is sufficient treatment for mild cases. Healing occurs in from three to six months. In severe cases testosterone in addition to immobilization will hasten recovery.

Seven cases are reported.

Eleven roentgenograms; 1 table.

SYDNEY J. HAWLEY, M.D.  
Seattle, Wash.

**Fractures of the Ankle. II. Combined Experimental-Surgical and Experimental-Roentgenologic Investigations.** N. Lauge-Hansen. Arch. Surg. 60: 957-985, May 1950.

To appreciate fully this paper one should review Part I, which was abstracted in Radiology 52: 297, February 1949.

The present study concerns the mechanism of fracture as determined by experimental fracturing of freshly amputated extremities. The pathologic anatomy was ascertained by dissection, the "genetic" roentgenologic diagnosis was established, and the "genetic" reduction technic of the fracture was determined (the latter will be taken up in a future paper). The fractures produced are described according to a dual designation which denotes the two main factors determining the individual type ("genetic factors" is the author's term), namely, the position of the foot at the moment of the forced movement producing the fracture. The designations are: supination-adduction, supination-eversion, pronation-abduction, pronation-eversion.

Anyone interested in fractures of the ankle should certainly read this article and correlate the pathological dissections with the reproductions of the roentgenograms. The observations may be summarized as follows:

**Supination-Adduction Fractures:** In Stage 1 most frequently there was detachment of the ligaments attached to the tip of the malleolus and the lower border (posteriorly) of the lateral surface of the talus, in connection with a small fragment of bone. In one case the site of the fracture was in the lateral malleolus itself and in one case just proximal to it. In both cases the fracture was horizontal and transverse. In Stage 2 fracture at the base of the medial malleolus was produced six times and detachment of the deltoid ligament from the same bone once.

**Supination-Eversion Fractures:** There are four stages of supination-eversion fracture, as follows:

#### Stage 1

Ligamentum malleoli lateralis anterior detached from tibia

Ligamentum malleoli lateralis anterior detached from lateral malleolus

Ligamentum malleoli lateralis anterior detached from both

#### Stage 2

Oblique spiral fracture of distal end of fibula

#### Stage 3

Splitting-off of large fragment from tibia dorsally

Avulsion of dorsolateral corner of tibia and of a bony rim along dorsal lip of tibia

Splitting-off of dorsolateral corner of tibia and of bony rim along dorsal lip of tibia plus detachment of periosteum on dorsal surface of tibia

#### Stage 4

Fracture of medial malleolus at base

Avulsion of a bony rim at insertion of deltoid ligament on medial malleolus

#### Variant

Oblique spiral fracture in distal half of tibia

**Pronation-Abduction Fractures:** Fracture of the medial malleolus is produced in Stage 1. Stage 2 consists in detachment of the ligamentum malleoli lateralis anterior, with a small fragment from the tibia antero-laterally, and detachment of the ligamentum malleoli lateralis posterior and ligamentum malleoli lateralis posterior distale, with a larger fragment from the dorsolateral and dorsal lip of the tibia or with a corresponding detachment of the periosteum from the tibia dorsally. Oblique fracture with a characteristic course of the fracture line and characteristic localization occurs in Stage 3.

**Pronation-Eversion Fractures:** From the experiments described, it appears that the mechanism active in this instance will produce four lesions in the ankle region and the fibula in a certain sequence. The first lesion is a pronation-abduction fracture. The second lesion is detachment of the entire ligamentum malleoli lateralis anterior, rupture of the ligamentum transversum cruris and the membrana interossea to a considerable extent, and detachment of the ligamentum interosseum tibiofibulare with the exception of its dorsal bundles. The third lesion is a more or less oblique or spiral fracture of the fibula from more than 8 to 9 cm. above the tip of the malleolus. The localization of the fibular fracture depends on how far proximally the tibiofibular ligamentous attachments rupture and how great the elasticity of these ligamentous systems is. If the fracture is at about the middle of the bone or proximal to it, the distal fibular fragment may rotate and be dislocated so much that the separation between the tibia and the fibula may be large enough to give space to the talus, so that a certain luxation takes place without rupture of the dorsal ligaments of the lateral malleolus and the dorsal bundles of the ligamentum interosseum tibiofibulare. The fourth lesion is detachment of the ligamentum malleoli lateralis posterior distale with a smaller or larger avulsion from the dorsolateral corner and the posterior lip of the tibia.

Nine roentgenograms; 12 drawings; 1 photograph.

S. F. THOMAS, M.D.  
Palo Alto, Calif.

## THE SPINAL CORD

**Diastematomyelia (Congenital Clefts of the Spinal Cord): Diagnosis and Surgical Treatment.** Donald D. Matson, Robert P. Woods, James B. Campbell, and Franc D. Ingraham. Pediatrics 6: 98-112, July 1950.

Diastematomyelia is a term which includes any abnormal cleft or division of the spinal cord or its intraspinal derivatives. This paper presents the authors' experience with 2 cases discovered inadvertently at the time of laminectomy and 9 cases in which the diagnosis was made preoperatively and surgical therapy was employed.



In most of the patients some form of cutaneous defect, usually in the midline, was present in the region of the underlying neural abnormality, as an abnormal tuft of hair, skin dimple, subcutaneous fat, port-wine stain, or cutaneous angioma. The presenting complaint in the majority of cases was of muscular imbalance in the lower extremities, gait disturbances, deformities of the feet, urinary or fecal incontinence, or increasing enuresis.

Roentgen diagnosis of diastematomyelia was made and later confirmed at operation in 8 of the 11 cases. The diagnosis is based upon observation of an abnormal line of increased density in the middle of the spinal canal due to a presence of a bony spicule arising from the posterior aspect of the vertebral body. The roentgenologic findings are the subject of another paper, to which the authors refer (Neuhauser, *et al.*: *Radiology* 54: 659, 1950).

Progressive neurologic impairment of the lower extremities and of the rectal and vesical sphincters may result from increasing distortion of the neural axis as a result of fixation of the spinal cord produced by the bony spicule during the growth period. Surgical treatment is undertaken as a prophylactic measure rather than a curative one. It consists in laminectomy with extradural removal of the bony spicule in so far as possible, followed by opening of the dura, with excision of its reflections adjacent to the spicule, excision of the remaining bony prominence down to the anterior dura, and division of all adhesions to the bifid cord or cauda equina.

Two roentgenograms; 9 photographs; 6 drawings.  
HOWARD L. STEINBACH, M.D.  
University of California

**Lumbar Spinal Extradural Cyst.** Frederic Schreiber and Aage Nielsen. *Am. J. Surg.* 80: 124-126, July 1950.

Since the report in 1934 of Elsberg, Dyke, and Brewer (*Bull. Neurol. Inst. New York* 3: 395, 1934) there have been published 22 cases of spinal extradural cyst, 9 of which were cervical, 19 dorsal, and 2 dorsal with lumbar extension. The authors report a case unique in the fact that the cyst was confined to the lumbar region and was unassociated with Scheuermann's disease (kyphosis dorsalis juvenilis), which has been present in practically all of the other cases.

A 27-year-old man was seen for the first time in November 1945, complaining of pain in the low back and left hip and leg, and paresthesia over the lateral aspect of the thigh, for a period of two and one-half years. Physical examination showed stiffness of the lumbar muscles and hyperesthesia of both little toes and over the lateral aspect of the thigh. Roentgenograms of the lumbar spine were regarded as normal, though a subsequent review showed erosion of the right pedicle and body of the second lumbar vertebra. The patient was thought to have a herniated disk and was placed in a cast for thirteen weeks.

Examination in May 1946 showed tenseness of the lumbar muscles and a list to the left on forward bending. A pantopaque spinogram demonstrated the bony lesion and a slight deviation of the neural sac to the left in this same region. At this time a diagnosis of extradural tumor was made.

The patient was operated upon on May 10, 1946, through a 5-inch midline incision over the second lum-

bar vertebra. The yellow ligament was thickened on the right, but the dura and the caudal nerves were normal. An extradural bluish cyst 2 inches in diameter was found at this level and was removed. Microscopic examination showed it to consist of arachnoid covered with fibrous membrane.

Postoperative recovery was uneventful. The lumbar pain was relieved but the patient still had some discomfort in his left leg.

Four illustrations, including 2 roentgenograms.

A. E. O'HARA, M.D.  
University of Pennsylvania

## GYNECOLOGY AND OBSTETRICS

**Principal Cause of Breech Presentation in Single Term Pregnancies.** Charles S. Stevenson. *Am. J. Obst. & Gynec.* 60: 41-53, July 1950.

The author has made a study of the soft-tissue abdominal roentgenograms of 76 pregnant women who had persistent breech presentation of a single fetus at term or in the last few weeks of pregnancy. In one-third of the cases the actual position of the placenta was checked against the roentgen findings by intrauterine palpation following delivery of the child but before delivery of the placenta. In all cases so checked, the roentgen description of the position of the placenta proved to be correct.

It was found that in each of the 76 cases the placenta was implanted in either the right or the left cornual region of the uterus. According to the combined averages (207 cases) of Holzapfel and Gusserow, the incidence of cornual implantation of the placenta is only about 7 per cent in all pregnancies. In view of these data, the author believes that cornual implantation of the placenta is the prime cause of persistent breech presentation in full-term infants. But, although all persistent breech presentations exhibited cornual implantation of the placenta, all cases of cornual implantation apparently did not result in breech presentations.

Of the 76 cases, 71 per cent exhibited implantation in the region of the left cornu; in only 29 per cent was the implantation in the region of the right cornu. The author puts forth a hypothesis to reconcile these curious findings and to explain why persistent breech presentation is more common in primiparous women. Briefly, the hypothesis is that the fetus adapts itself to the polarity of the uterus, which in normal women (without tumors, bony deformities, etc.) is determined by the placental site, parity, and the normal torsion, to the right, of the pregnant uterus (which progresses as pregnancy advances). With cornual implantation of the placenta, the smaller part of the oval space available to the fetus is in the region of the opposite cornu. The fetal head adapts itself to this region since it is the smaller end of the fetal oval. Torsion of the uterus to the right and parity may change the shape of the space available to the fetal oval and thus cause it to rotate out of the breech position normally caused by the cornual implantation of the placenta.

[This article is most interesting and well worth careful reading by those interested in this subject. The figure of 100 per cent cornual implantations in breech presentations immediately challenges the skeptic to disprove it if he can.—T.F.W.]

Three roentgenograms; 2 diagrams; 3 tables.

T. FREDERICK WEILAND, M.D.  
Jefferson Medical College

**Puerperal Involution of the Urinary Tract.** M. James Whitelaw, Stephen W. Cobb, and William F. Mengert. *Am. J. Obst. & Gynec.* 60: 192-195, July 1950.

It is well known that dilatation and hypertrophy of the urinary tract occur in pregnant women, but there is little agreement as to when the urinary tract returns to its non-pregnant state. For this reason the authors undertook to study a series of 23 normally pregnant women, eight of whom were primigravid. Initial excretory urograms were made prior to labor and two, four, and seven days postpartum.

It was found that involution of the right urinary tract was complete by the seventh day in three-fourths of the patients, and the left side returned to normal even earlier. In more than half of the series return to normal occurred within four days.

Involution was appreciably delayed in patients with puerperal infection.

Four roentgenograms; 1 graph.

HARVEY J. THOMPSON, JR., M.D.  
Jefferson Medical College

**Genitourinary Changes Following Gynecologic Surgery.** Samuel Lubin, Leo Drexler, Richard Waltman, and John Copalbo. *Am. J. Obst. & Gynec.* 60: 187-191, July 1950.

The frequency of symptoms referable to the urinary tract in primary disease in the genital system led to investigation of the extent and kind of actual change occurring.

Twenty-four cases were studied, including fibromyomata, postmenopausal bleeding, cysto-rectocele, third degree prolapsus uteri, prolapse of the cervical stump, bilateral dermoid cysts of the ovary, adenoma malignum of the uterus, chronic tubo-ovarian disease, and ovarian cysts. The investigation consisted of preoperative and postoperative cystometric studies, x-ray studies, and cystoscopy.

The authors found ureteral displacement, occasional hydronephrosis, bladder atonicity and hypertonicity (1 case).

In most cases correction of deformity was demonstrated by pyelograms following surgery. However, cystometric studies revealed persistence of loss of bladder tonus, probably accounting for continued bladder symptoms following surgical relief of pressure on the bladder or ureters.

Three roentgenograms.

HARVEY J. THOMPSON, JR., M.D.  
Jefferson Medical College

#### THE GENITO-URINARY SYSTEM

**Excretory Urography in the Young Subject. Hyaluronidase and Tomography as Aids.** M. H. Fain-singer. *South African M. J.* 24: 418-420, June 3, 1950.

The solutions to two separate problems in pediatric excretory pyelography are here presented. The problems in question are (1) the difficulty of giving the solution intravenously in small veins and struggling patients, and (2) the presence of gas in large amounts throughout the intestinal tract.

To meet the first difficulty, the author adds hyaluronidase to the contrast medium (diodone) and makes the injection intramuscularly (half into each hip). The enzyme causes rapid absorption of the dye, and the films are quite comparable to those obtained with intravenous injection.

To solve the problem of gas shadows, tomography is used, following sedation. The exposure time is short—0.2 to 0.3 seconds—permitting the tube to describe an arc of 20 to 25°. With the thicker section thus obtained, practically the entire thickness of the "renal plane" can be included and the gas shadows are insignificant. In practice, three films are exposed at depths 1 cm. apart, the optimum depth is selected, and subsequent films are obtained at this depth.

Four roentgenograms. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Pyelographic Misinterpretation and Nephrectomy in Essential Hematuria.** G. W. Günther. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 73: 42-54, May 1950. (In German)

Many needless operations have been done because of bleeding from the urinary tract of the "essential" type, especially where this was the only significant finding. This condition arises because of (1) over-emphasis on importance of blood loss; (2) lack of knowledge of the underlying process; (3) deep-rooted conviction that renal hematuria is of serious consequence. On opening the kidney, bleeding may be found from the pelvis or upper ureter with no recognizable tumor, tuberculosis, or other lesion. The author considers that such operations, carrying a 4.5 per cent mortality, should not be undertaken lightly or without a complete clinical and physical work-up. If there is any doubt he prefers medical management and watchful waiting for a reasonable period of time.

Errors may be easily made in pyelographic study, especially in the following conditions, which are discussed in detail:

1. Giant papillae, usually occurring in the cranial calyx and causing a flattened appearance, often strongly simulating a tumor or deformity due to tuberculosis.
2. Rupture of the fornix and sinus reflux, due to overfilling with dye or other artificial type of extravasation. In some cases release of spasm causes sudden pressure within the calyx resulting in reflux. As a rule these cases give a more irregular appearance, but considerable confusion may arise.
3. Calyceal spasm, which may strikingly simulate early tuberculous involvement.
4. Other abnormalities of filling of the kidney pelvis, due to spasm, calculi, or hydronephrosis with secondary inflammatory changes, sometimes on a sclerotic basis.
5. Retention or stagnation catarrh in a calyx, secondary to inflammatory changes with hemorrhage.

The author summarizes the chief causes of mistaken diagnosis as (1) congenital variations, such as giant papillae, diverticula, etc.; (2) errors due to the examination itself; (3) rupture and reflux into the kidney tissue; (4) functional and organic filling defects, misinterpreted as evidence of tumor or tuberculosis. Restudy at a later date, especially by means of serial spot films under fluoroscopic guidance, reasonable delay before operation, and complete analysis of clinical and physical findings will minimize the tendency to needless surgery.

Fourteen illustrations, including 9 pyelograms.

E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Morphology and Symptomatology of Renal Tumors.** G. W. Günther. Fortschr. a. d. Geb. d. Röntgenstrahlen 73: 30-42, May 1950. (In German)

The cardinal signs of kidney tumor are pain, bleeding, and a palpable mass. None of these are characteristic and considerable confusion arises from the clinical and physical aspects of the case, and especially from the mistaken concept that bleeding must necessarily be associated with tumor. This has led to needless operation in many cases.

The author divides the cases coming under his experience into five classifications, which he illustrates by individual case reports:

*Case 1:* The patient complained of right-sided crampy pain, and a tumor, on the left side, was more or less an incidental finding. Retrograde pyelograms showed distortion of the pelvis, particularly the lower calyces, and evidence of pressure from a mass below the calyces. The right-sided pain apparently had nothing to do with the tumor, which was completely asymptomatic.

*Case 2:* Bleeding was intermittent with worm-like blood clots. Roentgen examination showed lack of filling within the pelvis and the upper ureter, due to a mass. Pain and hematuria were attributable to involvement of the pelvis and upper ureter.

*Case 3:* Colic was present in the left kidney region, and there was recurrent bleeding at approximately three- to four-month intervals. Worm-like blood clots had been passed after an attack of pain. Examination by intravenous urography showed a functionless left kidney. Tumor was considered among other diagnoses but was finally established only at the operation. Bleeding was due to a surface infarct of the hemorrhagic type in a rather small portion of the tumor.

*Case 4:* The patient gave a history of bleeding for eight months, with free intervals of only a few days, and pain in the right kidney region. X-ray study showed gross deformity of the pelvis of the "spider" type. Bleeding was due to the associated inflammatory changes and not to the tumor itself.

*Case 5:* The patient passed blood clots and complained of pain in the left kidney region, frequency, and involuntary micturition. X-ray studies showed a very severe grade of deformity of the entire kidney pelvis. There proved to be thrombosis of a branch of the renal vein and pyelitis. Bleeding was from the pyelitis and not from the tumor.

The author believes that pain and bleeding in patients with kidney tumors originate in the pelvis or upper ureter, often secondary to inflammatory changes. Independent of the actual size of the tumor, it bleeds only when it actually extends into the pelvis or calyces or when a secondary pyelitis is present.

Twelve illustrations, including 6 roentgenograms.

E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Renal Dysplasia in a Family with Multiple Hereditary Abnormalities Including Iliac Horns.** C. F. Hawkins and O. E. Smith. Lancet 1: 803-808, April 29, 1950.

Records of families suffering from a condition indistinguishable from chronic glomerular nephritis have appeared in the literature occasionally since the beginning of this century. There is little doubt that the condition is hereditary and familial, for often several successive generations of a family are affected. The

etiology of this so-called familial nephritis has not been clarified by histologic study of the kidneys. Renal function is slightly diminished and roentgenography shows kidney shadows of normal size and shape. Studies with uroselectan exclude polycystic disease. The family studied by the authors presented a number of associated anomalies, whose congenital nature is indisputable. The association suggests that the renal lesion is also an inherited developmental anomaly. Thirty-six members of the family were traced or observed, and developmental anomalies of some kind were discovered in 21. In most instances the bony change was apparent only on roentgen examination. Four members of the family were found to be suffering from a renal lesion similar to chronic glomerular nephritis.

The abnormalities observed in this family affected tissues of both ectodermal and mesodermal origin. The commonest trait involved the fingernails, elbow joints, and patellae, and is known by the family to have been inherited from distant ancestors. Two men had some degree of "pigeon chest"; 3 others had a moderate degree of multiple angiomas of the skin. There were 5 examples of spina bifida of the lower cervical spine associated with abnormally long transverse processes of the seventh cervical vertebra. In 3 other cases cervical ribs articulated with normal vertebrae. One child in the third generation had polydactyly.

Nine members of the family were found to have iliac horns, an anomaly previously reported by Fong (Radiology 47: 517, 1946). [See also the report by Thompson, Walker, and Weens of 4 cases of iliac horns, in which the fingernails, elbow joints, and patellae were affected as well (Radiology 53: 88, 1949).—Ed.]

Eight illustrations, including 5 roentgenograms.

**Renal Hydatid Disease.** V. S. Howarth. Brit. J. Surg. 38: 38-51, July 1950.

Hydatid disease of the kidney is a rare condition. Only 44 cases of renal cysts were present in a total of 2,002 cases of hydatid disease recorded in the Louis Barnett Hydatid Registry of the Royal Australasian College of Surgeons.

Five cases of renal hydatid disease are reported here, in none of which was an accurate preoperative diagnosis made. Interpretation of the pyelogram in cases of "closed" renal hydatid cyst can be very difficult, and in some cases diagnosis is impossible. A renal neoplasm may present an identical appearance. Large cysts may be present without displacement of the kidney. One patient had a rounded, calcified cyst which had to be differentiated from renal lithiasis and renal calcification of other etiology.

Under favorable conditions spontaneous cure of renal hydatid disease may occur following rupture of a cyst into the renal pelvis.

Eight roentgenograms; 6 photographs in color.

HOWARD L. STEINBACH, M.D.  
University of California

**Topographic Urethrography. Part I.** Thomas L. Ball. Am. J. Obst. & Gynec. 59: 1243-1251, June 1950.

The author points out the need for a method to measure the precise position of the bladder neck both before and after surgery for urinary incontinence so that the operative procedure can be selected intelligently and its results evaluated more accurately. He has devised a roentgen method of measurement which he calls "topographic urethrography."

The method consists essentially in measuring distance relationships between the external urinary meatus, the bladder neck (used synonymously with the term "internal sphincter"), and the symphysis pubis. Measurements are made on true lateral isometric roentgenograms of the pelvis, with the shadow of a metallic ruler placed in the mid-line near the symphysis being recorded on the films. Films are made with the patient sitting with the back forming an angle of 30 degrees with the horizontal, and also standing. In each instance they are made in "rest," "strain," and "hold" positions. The external meatus is marked by a metal marker, the urethra is marked by opaque medium (30 per cent sodium iodide) in the sheath of an especially devised catheter, and the bladder neck is marked by sodium iodide in the Foley bag of the catheter. Sodium iodide (5 per cent) also outlines the full bladder.

The success of the examination depends upon accurate localization and outlining of the shadow of the symphysis pubis on the films. This apparently is not always a simple matter, and the author devotes some space to the description of landmarks and devices to be used. When the symphysis has been outlined accurately, a straight line which roughly bisects it longitudinally is drawn. It is this line, called the lateral bore of the symphysis, and its junction with the inferior border of the symphysis which serve as reference points for the measurements.

In order to have normal standards for later study of incontinent women, observations were made on 27 continent women. Ten were nulliparae and the rest multiparae. Of the 17 multiparous women, 11 clinically showed "slight relaxation," and 6 showed "relaxation and prolapse." Most of the group of normals with prolapse were apparently awaiting vaginal hysterectomy or Manchester type repairs when studied.

The average normal positions of the external meatus and the bladder neck in regard to the symphysis pubis and their average normal excursions in "hold" and "strain" positions were determined. It was found, also, that the urethra is usually a little more anterior and inferior to the symphysis in the standing than in the sitting position; that the urethra is more anterior and inferior to the symphysis in multiparous than in nulliparous women; that continent women with prolapse show good paraurethral support; that the relaxation of the vaginal wall in these women is posterior to the bladder neck.

[For the practical application of these observations, see the following abstract.]

Seven illustrations, including 3 roentgenograms; 2 tables.

T. FREDERICK WEILAND, M.D.  
Jefferson Medical College

**Topographic Urethrography. Part II.** Thomas L. Ball, R. Gordon Douglas, and Lynn L. Fulkerson. *Am. J. Obst. & Gynec.* 59: 1252-1259, June 1950.

Ball and his associates applied his roentgen method of location of the bladder neck (see preceding abstract) to a study of 33 incontinent women. It was found that stress incontinence is associated with displacement of the bladder neck downward and forward in relation to the symphysis pubis. This results in an accordion effect on the inner third of the urethra and a funneling of the bladder neck. The forward movement is apparently the more significant of the two. Thus, one cannot be guided solely by the presence or absence or the size of a urethrocele in studying incontinence in women.

Further, one cannot determine accurately the position of the bladder neck by vaginal examination alone.

Abnormal mobility of the bladder neck, particularly in an anterior direction, is noted in both multiparous incontinent women (27 patients) and in nulliparous (congenitally) incontinent women (6 patients). The abnormal mobility in the multiparous women with slight relaxation of the anterior vaginal wall (20 cases) is less than in those with marked relaxation and prolapse (7 cases), but the abnormal movements are in the same direction.

The authors suggest that roentgen measurements may be helpful in guiding the surgeon in placing the sutures accurately in plication of the bladder neck. A sterile ruler is suggested for use at operation to determine the exact anatomic position.

Six roentgenograms; 1 drawing; 2 tables.

T. FREDERICK WEILAND, M.D.  
Jefferson Medical College

**Demonstration of the Bladder and Urethra by Means of Water Soluble Contrast Medium.** Nils P. G. Edling. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 73: 18-29, May 1950. (In German)

After a general discussion of the historical aspects of urethrography, the author points out the advantages of a water-soluble contrast medium introduced by the injection method. Since the water-soluble iodine preparation has a tendency to cause slight burning in the urethra, a mild local anesthetic is employed. Films are made in the anteroposterior, and right and left oblique positions, followed by micturition pictures when indicated. No significant complications were noted, nor were any indications of sensitivity to the dye observed.

The author discusses the normal appearance and anatomy of the bladder and urethra and stresses the fact that examination during micturition often clarifies the appearance, especially of the posterior urethra.

Strictures, either congenital or acquired, are well demonstrated by a local area of narrowing and proximal dilatation. Congenital strictures are usually observed near the bladder neck; acquired strictures in the membranous or anterior urethra. Delay in emptying is often associated with other typical signs. Sometimes an associated paraurethral filling of the ducts and lumen of the prostate and urethral glands results from back pressure.

Tuberculosis and septic conditions cause a somewhat similar appearance, with abscess cavities and, in later stages, calcium deposits. Often the prostatic utricle and the colliculus are obliterated. By filling the ductus deferens and seminal vesicles (direct injection), gross irregularity may often be demonstrated, with cavitation due to abscess formation. Occasionally a urethrorectal or vaginal fistula can be recognized. Filling of the ducts and glands about the urethra represents the so-called "false passage." Seldom are the anterior urethral or Cowper's glands demonstrated in this manner.

With atrophy of the prostate resulting from a previous inflammatory process, one sees a moderately dilated prostatic urethra above the colliculus and a small bladder with no deformity of the lumen. Later stages show stiffening of the prostatic urethra.

In prostatic hypertrophy there is elongation of the prostatic urethra, with elevation or impression on the base of the bladder, sometimes associated with swelling of the colliculus. [The author does not mention defects



produced in the air-filled bladder by the lateral lobes, or the so-called "horsecollar effect" by enlargement of all three lobes.] Adenomatous enlargement of the prostate shows a similar appearance with lateral compression of the prostatic urethra and ventral angulation (the so-called "anterior tilting"). In advanced or late cases this may be associated with lateral displacement. Involvement of the third or median lobe may cause impingement on the urethra at the neck of the bladder, with partial obstruction.

Carcinoma, especially in the earlier stages, is extremely difficult to differentiate from simple hyperplasia and adenoma. As the disease progresses, irregular areas of pressure and infiltration appear, often associated with more or less obstruction, contraction, and rigidity of the bladder neck.

Postoperative cases and the neurogenic types of bladder disease are frequently investigated by the technic described, as well as the usual types of tumor calculi, diverticula, etc., within the bladder.

A brief discussion is given of the female urethra, in its normal and pathological aspects.

Twenty roentgenograms.

E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Clubbing of Digits, Metaplasia of Urinary Bladder and Mucous Diarrhea.** Thomas A. Warthin, John F. Cooper, and Anthony P. Caputi. *Arch. Int. Med.* 86: 10-21, July 1950.

Four cases are presented illustrating clubbing of the digits for months or years prior to the onset of frequency, dysuria and mucous diarrhea. In only one case was there any evidence that the clubbing was hereditary. Bladder biopsies revealed cystitis cystica and cystitis glandularis; 2 cases examined by intravenous pyelography showed irregularities of the bladder wall and slight dilatation of the terminal portions of the ureters. Clubbing of the fingers was due to soft tissue enlargement in 2 cases, and was associated with definite bone changes in the digits and long bones in the other 2. A complete work-up failed to reveal any other significant changes.

The common embryologic origin of the germ layers of the involved tissues is discussed, and factors which might be active in the pathogenesis of cystitis glandularis are presented.

Two roentgenograms; 2 photomicrographs; 1 photograph.

HARRY J. PERLBERG, JR., M.D.  
New York, N. Y.

### THE BLOOD VESSELS

**Arteriography in the Evaluation of Arteriosclerotic Vascular Insufficiency.** Darrell A. Campbell and R. Glenn Smith. *Am. J. Surg.* 80: 76-79, July 1950.

The authors review the results of peripheral arteriography in over 100 patients hospitalized for vascular insufficiency. The method used was described by them in an earlier paper (*Surgery* 24: 655, 1948. *Abst. in Radiology* 53: 460, 1949). Tracings are presented of a normal arterial pattern of the lower extremity and various patterns of arterial insufficiency. The latter include irregularity and constriction of the major vessels but without occlusion of any one of them; complete occlusion of one or two but not all three major vessels below the popliteal artery; segmental occlusion, with a patent collateral system sufficient to fill a major vessel

below the point of obstruction; complete obstruction below the popliteal artery; complete obstruction in the thigh. It is concluded that the procedure may be helpful in determining the most desirable type and site of amputation, and may indicate patients more suitable for sympathectomy. It is recommended only for large peripheral vascular clinics and not as a routine procedure.

Six tracings of arteriograms.

ROBERT L. RAPHAEL, M.D.  
University of Pennsylvania

**Venography in the Postphlebotic Syndrome.** Clarence V. Kusz. *Minnesota Med.* 33: 619-623, June 1950.

Iliofemoral thrombophlebitis is usually followed in months to years by a syndrome characterized by edema, pain, recurrent cellulitis, pigmentation, and ulceration—the so-called postphlebotic syndrome. This is associated with loss of the venous valves and downward flow of the blood in the erect position.

By direct femoral venography, the author demonstrates reflux of opaque material into the veins of the thigh. The patient is placed in 45-degree upright position. A direct puncture is made with a 19-gauge needle into a common femoral vein, and 30 c.c. of 35 per cent diodrast are injected rapidly. A roentgenogram is made immediately after the injection, and another one minute later. In the normal femoral vein, the opaque material does not flow downward. In the abnormal, there is reflux of the medium into the veins of the thigh.

By a popliteal venogram the author demonstrates gross communication between the superficial femoral vein and the profunda femoris vein above the knee. This is done with the patient in the 54-degree upright position, facing the table. The injection is made into the popliteal vein at the level of the upper border of the patella; 30 c.c. of 35 per cent diodrast are introduced, and exposures are made immediately and after one minute. The author feels that when this incompetency is demonstrated, ligation of the popliteal vein is the most logical procedure for relief of symptoms.

Thirteen venograms; 1 photograph.

PAUL W. ROMAN, M.D.  
Baltimore, Md.

**A Study of Atherosclerosis in a Group of Diabetic Patients.** Joseph I. Goodman, Sigmund Wasserman, Louis J. Marcus, and Leonard Frankel. *Am. J. M. Sc.* 220: 30-45, July 1950.

The authors feel that the rising incidence of arteriosclerosis and its complications as a cause of death should lead one to make every effort to determine its presence. Inasmuch as the incidence is known to be unusually high in the diabetic, a group of 80 unselected patients attending the diabetes clinic, Mt. Sinai Hospital, Cleveland, Ohio, was studied. The patients' ages ranged from eighteen to ninety-one years; the majority were over fifty.

Atherosclerosis (intimal sclerosis) appears to be localized in two principal segments of the arterial tree: (1) proximal (central) atherosclerosis, in the thoracic aorta, its adjacent great vessels and such important branches as the coronary artery, the carotid artery and its cerebral branches; (2) peripheral (distal) atherosclerosis, in the abdominal aorta, the pathological processes of which are intimately associated with atherosclerosis in the iliac and femoral arteries.



In detecting changes in the arteries in these two major groups, various tests were used. In proximal atherosclerosis, (1) increased width of the aortic arch was found radiologically and by percussion in 93.1 per cent of the cases; (2) calcification of the thoracic aorta was demonstrated by x-rays in 41.5 per cent; (3) the carotid-sinus pressure test was positive in 68.6 per cent; (4) abnormal supraclavicular pulsations were present in 57.5 per cent. These four tests and procedures were found to be of diagnostic value. The electrocardiogram, blood pressure readings, and aortic auscultation were thought to be of less significance.

For detecting peripheral atherosclerosis, roentgen and clinical studies were used. Calcification in the abdominal aorta demonstrable roentgenologically was thought to represent intimal sclerosis, that in the pelvic, iliac and femoral arteries, medial sclerosis. The clinical studies included (a) history, (b) inspection of skin, nails, hair, etc., (c) color changes, (d) oscillometric examinations.

It was found in correlating the roentgen and clinical findings in the peripheral group that among patients showing clinical evidence of impaired circulation calcification of the abdominal aorta was present in 65.8 per cent, calcification in the pelvic vessels in 73.1 per cent, and calcification in the femoral vessels in 75.6 per cent, as compared to 45.8 per cent, 45.8 per cent, and 35.4 per cent, respectively, in cases in which no disturbance of circulation was found clinically.

In conclusion the authors feel that the most reliable procedures in detecting the presence of atherosclerosis are (1) the carotid-sinus pressure test, (2) palpation of pulsations in the supraclavicular fossae, (3) visualization of plaques in the aortic arch, (4) roentgen demonstration of calcification of the abdominal aorta, (5) clinical examination of the extremities. The first three procedures, when positive, indicate proximal atherosclerosis; the latter two, atherosclerosis of the abdominal aorta and its branches.

For those interested in this problem the original paper and its details as to individual tests, percentages, and pathologic changes is recommended.

Three roentgenograms; 2 photomicrographs; 2 tables.

ISRAEL R. BERGER, M.D.  
Louisville, Ky.

**True Renal-Artery Aneurysm. Report of a Case.**  
Robert R. Berneike and Henry M. Pollock, Jr. New England J. Med. 243: 12-14, July 6, 1950.

True renal-artery aneurysms are presumed to be degenerative or inflammatory changes with trauma as a possible precipitating factor. Males are somewhat more frequently afflicted than females, and the age distribution of reported cases is from nine months to eighty-two years. There is usually a dull, mild aching pain in the flank or upper abdomen, and hematuria—usually massive and often fatal—may occur if perforation develops. A tumor is palpable only when the aneurysm reaches a large size. Hypertension was present in 11 of 56 cases from the literature, and in only 3 of the 11 did blood pressure return to normal after nephrectomy.

The x-ray findings are quite characteristic. Calcification of the aneurysmal sac is usually of a circular form and often incomplete. The location is anterior to the renal pelvis and medial to the upper third of the kidney. The kidney may be displaced laterally, and the upper major calyx and the upper pelvis may be deformed by pressure.

Once the diagnosis has been made, it is mandatory that the kidney be removed to prevent fatal hemorrhage.

The authors report what they believe to be the 91st case of renal-artery aneurysm. The patient was a 32-year-old male who complained of pain of two weeks duration in the left costovertebral angle. At the age of nine he was said to have had "rheumatism," confining him to bed for four weeks, complicated by a cardiac lesion. His later life, however, was marked by athletic activity and active Army duty. At examination, the blood pressure was 180/100, but it was subsequently found to vary from 120/80 to 140/90. Other physical findings were essentially normal, as were urinary tests. X-ray examination showed a spherical mass about 6 cm. in diameter just medial to the upper pole of the left kidney, incompletely outlined by a curvilinear calcification. The kidney was displaced laterally and there was evidence of pressure on the upper calyx and renal pelvis. The mass was seen to lie anterior to the renal pelvis. A review of a lumbar spine roentgenogram made two years earlier showed a partly calcified mass in the upper left quadrant about two-thirds the size of the present one.

A nephrectomy was done and the pathologist reported a renal-artery aneurysm. Postoperatively pain was relieved and the blood pressure was 120/80.

One photograph. JOHN B. MCANENY, M.D.  
Johnstown, Penna.

## TECHNIC; GENERAL CONSIDERATIONS

**Horizontal Body Section Radiography.** J. J. Stevenson. Brit. J. Radiol. 23: 319-334, June 1950.

Horizontal body section radiography is an extension of laminagraphy (tomography, stratigraphy, etc.). The examination is made with the patient erect on a rotating stool. The x-ray beam is directed obliquely through the level desired. The film lies on a horizontal table. The patient and the support for the film are rotated synchronously. The apparatus used is described and illustrated, and studies of various diseases in the neck and thorax are reported. In spite of the fact that some of the films are difficult to interpret in the illustrations, the method offers definite possibilities.

Thirty illustrations. SYDNEY J. HAWLEY, M.D.  
Seattle, Wash.

**Radiology in the Rural Practice.** Joseph C. Bell. J. Kentucky State M. A. 48: 270-275, June 1950.

The aims and conclusions of the Conference on Rural Radiology at the 1949 meeting of the American College of Radiology were explained and discussed by Dr. Bell, Chairman of the Committee, before the state meeting of the Kentucky Medical Society.

The ideal situation is a full-time service, where the volume of work justifies it, under a trained radiologist. Next best is part-time coverage of several communities on a specified schedule. Each visit of the radiologist must be long enough to allow for instructing technicians, consulting with referring physicians, and, if possible, attending staff meetings. The least desirable procedure is that in which films are sent to the radiologist for examination and he reports by phone or mail. The non-radiologists agreed that a fee should be paid for consultations of this latter type.

Several ideas were expressed in regard to teaching.

First of all, more and better training in radiology should be given by the medical schools, especially in matters of technic. Secondly, annual postgraduate seminars should be held in state medical centers, devoted to the basic principles and technic of various x-ray procedures.

Dr. Bell believes that therapy should be in the hands

of the radiologist, since so much experience and training are necessary for intelligent use of a potentially dangerous medium, but disagreement on this point was expressed in the ensuing discussion. Plans for carrying out the aims of the American College of Radiology in Kentucky were presented. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

## RADIOTHERAPY

**Advances in Radiotherapy.** T. A. Watson. Canad. M. A. J. 62: 540-544, June 1950.

The author presents an interesting survey of radiotherapy dating from Roentgen's initial discovery of x-rays in 1895. The effect of roentgen rays on the skin was soon observed and this led almost immediately to their therapeutic use in nevus, cancer, and tuberculosis. With the acceptance of the r as a unit of roentgen irradiation, in 1928, radiotherapy started to emerge from a long period of empiricism which had retarded its development. In 1937 the definition of the r was broadened to include the gamma rays of radium.

Radium treatment was revolutionized by the dosage system popularized by Paterson and Parker of Manchester in 1934. In this same year Irene Curie and her husband, Frederick Joliot, succeeded in producing artificial radioactivity. A few cancers of the thyroid (about 1 in 30) have been successfully treated with radioactive iodine, but this preparation finds its chief application in thyrotoxicosis. Radioactive phosphorus has been most successful in the treatment of polycythemia vera. Radioactive cobalt 60 with a half life of five years gives off gamma rays similar to those of radium. Large amounts of gamma rays from this substance can be mounted in a thick lead container, with an opening on one side, and used in the same way as an x-ray machine and at about one-tenth the cost of a 2,000,000-volt x-ray machine, which would be necessary to produce gamma rays of similar quality.

Fluorescein, containing radioactive iodine, is concentrated in brain tumor tissue and, by the use of a Geiger counter, areas on the skull showing intense activity can be marked out to determine the site and depth of a brain tumor.

As to supervoltage x-ray machines, most of the advantages of higher voltage lie in their physical properties. The higher the voltage, the more penetrating the rays and the greater percentage reaching deeper parts. Higher voltages have also been obtained by the use of special devices such as the cyclotron and the betatron.

It has been fifty years since Roentgen's discovery. The first forty years were spent in the developing and harnessing of x-rays to medical use. In the last ten years there have been many new discoveries in nuclear physics which are gradually being applied to medicine.

ROBERT H. LEAMING, M.D.  
Jefferson Medical College

**Discussion on the Chemical Factors Modifying Radiotherapeutic Response.** Frank Ellis, L. A. Elson, Benjamin Jolles, *et al.* Proc. Roy. Soc. Med. 43: 399-410, June 1950.

Opening a discussion of the chemical factors modifying response to irradiation, Dr. Frank Ellis states that, as a result of increasing understanding of the chemical effects of radiation and a wider knowledge of the way

in which it affects living tissues, we may hope to use it with more insight so that (1) the margin between tolerance of normal tissues and sensitivity of malignant cells may be increased and (2) we can condition malignant cells in order that they will be destroyed by smaller doses of radiation than are now used. He reviews the present-day knowledge and theories of the action of ionizing radiations in aqueous solutions and lists certain specific facts which have been observed, both chemically and histologically, which might indicate the way in which chemical factors influence response to radiation.

The beneficial effect of oxygen in irradiated tissues and the protective effect of a sulfur atom in a molecule has been shown. Substitution of the oxygen of urea by a sulfur atom increases the protective effect about 2,400 times. According to the author, this may be significant when considering the importance of sulfhydryl groups in biological reactions.

Also discussed are the effect of radiation on mitotic inhibition and degeneration of cells and the production of a breakdown product in irradiated tissue, called a diffusible substance, which apparently by a chemical effect causes increased reaction and less rapid recovery as the size of the irradiated area is increased.

Emphasis is placed on the fact that the only difference between a normal and a malignant cell is in the urge of the latter to grow and divide, irrespective of the chemical restraint of surrounding tissues. Therefore, the author believes, there is little prospect of destruction of cancer cells by chemical substances given systemically without the destruction of other normal dividing cells in the body. However, with safe doses, growth restraint can be accomplished.

Radiation is likely to be the most selective agent because it can penetrate to the nucleus of the cells. It must be used, therefore, as effectively as possible.

The discussion includes further the effect of many substances on radiation. These include antibodies, sulfonamides, synthetic vitamin K, nitrogen mustard, urethane, and sex hormones.

Dr. L. A. Elson reports investigations of the effect of diet on the response to radiation. In several different sets of experiments direct irradiation was given daily to established tumors in groups of animals on either a 5 per cent or 20 per cent protein diet. The effect of the low protein diet in irradiated animals was definite tumor inhibition for a considerable time but the animals were not able to rid themselves of tumor and none survived. In animals on high-protein diet the tumors grew rapidly at first but after multiple treatments the tumor ceased to grow, and in some animals there were cures. When higher initial doses were given (1,000 r) the marked difference was no longer observed between the immediate response of the low- and high-protein-diet groups.

It is concluded, therefore, that in considering the dietary effect, one should separate to some extent the processes which determine (a) the initial response of the tumor, which is favored by a low-protein diet and (b) the elimination of the inhibited tumor and cure of the animal, which are favored by a high-protein diet. By suitable fractionation of the dose, however, it is possible to apply a first dose of radiation high enough to cause adequate growth inhibition even in animals on a high-protein diet, so that the subsequent outcome of the treatment then depends almost solely on process b, and a favorable result is to a very large extent dependent on a high-protein content of the diet.

Dr. Benjamin Jolles describes a new method (1949) of treatment of accessible tumors which is a complete departure from all existing procedures in both fundamentals and technical details. Portions of the tumor, 1 cm. square, are exposed to radiation, while similar 1 cm. square areas are shielded, thus protecting important structures which can contribute to repair. After a suitable period of treatment, another chessboard sieve is used, the opaque and transparent areas being reversed. [This technic is described in greater detail in *Lancet* 2: 603, 1949. *Abst. in Radiology* 55: 311, 1950.]

Jolles also reported on the reciprocal vicinity effect of irradiated tissues brought out by a series of experiments on volunteers. A dose of x-rays was given to two small areas of skin separated by varying widths of untreated protected skin. These experiments showed the reactions produced to be significantly greater than that over a single area of skin exposed to the same dose of radiation. However, when the separation between paired areas exceeded a certain minimum value, the reaction was equal to that of a single area. The separation values necessary to abolish the reciprocal vicinity effect are listed and vary according to the areas treated.

The cause of this effect is a complex mechanism in which, among others, a diffusible substance produced in the directly irradiated parts might play a role. It is suggested that, apart from the reactivity of the surrounding unirradiated tissue, this diffusible substance might be responsible for events taking place in the parts of the tumor shielded from the direct beam. [See also the author's paper in *Brit. J. Radiol.* 23: 18, 1950. *Abst. in Radiology* 55: 932, 1950.]

Seven illustrations. RICHARD A. ELMER, M.D.  
Emory University School of Medicine

**Radiotherapy of Pituitary Adenomas.** Franz Buschke. *West. J. Surg.* 58: 271-278, June 1950.

This discussion of pituitary adenomas and their treatment is confined to chromophobe and eosinophil types. While it was originally believed that only eosinophil adenomas were amenable to radiation therapy, it is now agreed that, with improved techniques, chromophobe tumors may be treated with equal likelihood of success.

Two types of radiation technic have been used: (a) the interval technic, which delivers a fairly small dose in each treatment course, repeating the course at intervals of weeks or months either according to a planned schedule or as indicated by signs and symptoms of reactivation; (b) the single course technic, which aims to deliver a dose sufficient for permanent arrest of the tumor in a single course. A comparison of results with the two methods as shown by two large groups of cases (Davidoff and Feiring: *Am. J. Surg.* 75: 99, 1948;

Kerr: *Am. J. Roentgenol.* 60: 348, 1948) is given in the form of a table, which includes, also, the results in a surgical series.

	Surgery (Davidoff)	Irradiation	
		(Davidoff: 3 to 4 courses 4 to 8 weeks apart; 3,000 r in air per course)	(Kerr: 8,000 or 9,000 r, in air, in a single course of 3 to 4 weeks)
		Satisfactory	Satisfactory
All cases	59*	36 (61%)	88
Chromophobe	52	34 (65%)	59
Eosinophil	5	2 (40%)	29
		43 (49%)	50†
		25 (42%)	37
		18 (62%)	11
			36 (70%)
			26 (70%)
			8 (72%)

\* One carcinoma and 1 basophil adenoma.

† One basophil and 1 mixed tumor.

From these figures it is apparent that the most satisfactory results have been obtained with the single massive course procedure: in chromophobe adenomas 70 per cent as compared with 42 per cent, and in eosinophil adenomas 72 per cent as against 62 per cent. As might be expected, the discrepancy is less marked in the eosinophil group because in general they are more responsive to smaller doses.

The disadvantages of roentgen therapy are the futility of treatment in the presence of a cystic tumor, the at times difficult diagnostic differentiation from other intracranial lesions which would not be benefited by irradiation, and the slower relief of pressure on the optic nerve, possibly with occasional increase of pressure due to reactive edema of the tumor tissue.

The following conclusions are reached: (1) Radiation therapy in the form of a single massive course is the primary procedure of choice in cases in which a diagnosis can be made with a reasonable degree of certainty and in which damage to the optic nerve has not yet reached the point of imminent danger of blindness.

(2) In patients with imminent danger of blindness, primary surgical decompression of the sella is preferable because it relieves pressure more rapidly.

(3) Following radiation therapy, careful regular observation is necessary in order to determine the effect or the failure of treatment. If there is any progression of clinical symptoms or objective signs, surgical decompression should be resorted to because either the tumor has been treated under an erroneous diagnosis or it belongs to the group not sufficiently influenced by radiation therapy because of cystic changes.

(4) If there is either improvement or no change in objective symptoms following irradiation, watchful observation is indicated, sometimes for months.

(5) In deciding on the necessity of surgery, one should keep in mind that while the average mortality in larger series operated upon by excellent surgeons is around 10 per cent, it is higher in a selected group of post-irradiation failures which represent in general more advanced lesions.

(6) Treatment should be given in co-operation with a competent neurosurgeon.

(7) If from clinical, radiographic, and ophthalmological findings the diagnosis of pituitary adenoma cannot be made with reasonable certainty, it will depend on careful evaluation of the individual factors whether a

therapeutic test with irradiation under careful observation of objectively demonstrable results or primary surgical exploration is preferable. If exploration reveals a pituitary adenoma, surgery should be followed by irradiation of the same type as used in instances in which operation is not done.

Five tables.

#### Radiation versus Surgery for Cancer of the Tongue.

George S. Sharp, Eugene W. Demaree, and Robert E. Pugh, Jr. *West. J. Surg.* 58: 257-270, June 1950.

The fundamental considerations which the authors found to be most important in the management of cancer of the tongue are: 1. Biopsy at the first examination. 2. Immediate treatment, without waiting for diagnostic conclusions; the situation is urgent. 3. The size of the lesion presented, not only for prognosis, but as an important factor in determining the method of treatment. 4. The importance of the base of the lesion as the criterion for any treatment, whether surgical or radiation. The point of maximum infiltration must be eradicated. 5. Calculation of tissue dosage at the base of the lesion, being certain that the exposure is adequate and that the needles are of adequate active length if interstitial radium is used.

This present report covers an experience with 84 cases, males predominating three to one, though the percentage of females is roughly 10 per cent greater than is usually reported.

This series of cases confirms the general observation that cancer of the tongue is a highly aggressive disease in which metastases occur early; 48 per cent of the patients presented clinical evidence of metastatic lesions on admission and in 12 per cent nodes developed during the course of the disease.

The authors obviously prefer interstitial radium therapy to intracavitary x-ray irradiation but use both. Their charts showing the distribution of radiation about their needles as well as their depth dose estimations from the intra-oral cones are worth examining. Illustrative cases are presented with excellent before-and-after photographs. The results are tabulated:

Stages	Percentage living free of disease
Stage 1: A primary growth of less than 1.5 cm. in diameter.	75
Stage 2: A primary growth of less than 3.0 cm. in diameter.	57
Stage 3: A primary growth of any size but with unilateral operable cervical nodes.	30
Stage 4: A primary growth with invasion of surrounding structures and inoperable cervical metastases.	0.5

By using two-stage implantation of interstitial radium needles in cylindrical configurations, with the axis the second time at right angles to its direction the first time, the authors avoid the necessity of crossing the open distal end of the cylinder with lateral needles in a plane normal to the axis of the cylinder. They believe

that thus there is less local necrosis immediately surrounding the needles and less chance of missing an obscure tentacle of infiltration.

Sixteen illustrations:

S. F. THOMAS, M.D.  
Palo Alto, Calif.

#### Radiotherapy of Early Cancer of the Larynx. Five Year Results in One Hundred and Fifty-Six Cases.

Max Cutler. *J. A. M. A.* 142: 957-962, April 1, 1950.

Although cancer of the larynx is one of the less common forms of neoplastic disease, it is important because its treatment is becoming increasingly effective. Both surgery and radiotherapy play a role in the treatment. The selection of the type of treatment is dependent upon the patient's general condition, the extent of the lesion, the site of origin, and to some degree upon the microscopic structure of the neoplasm. The mobility of the laryngeal structures also affects the choice and efficacy of treatment. Mobility generally indicates that the lesion is early or, if more advanced, that it is papillary and not infiltrating. Such a lesion is radiosensitive and to a considerable degree radiocurable. Immobilization may be due to neoplastic infiltration or to inflammatory reaction. If it is due to inflammation, it generally begins to diminish and disappear soon after irradiation is begun.

If the carcinoma is early and involves only the true cord, the choice of treatment lies between laryngofissure and radiotherapy. The results of radiotherapy are at least as good and generally the voice is better than after operation. If the lesion has extended beyond the true cords and yet is confined to the larynx, the choice of treatment lies between laryngectomy and radiotherapy. The general consensus of opinion is that radiotherapy is the treatment of choice if the lesion has not totally fixed the cords. Total laryngectomy is reserved for advanced lesions with complete fixation of the cords, occurring in surgical subjects with a good life expectancy. In borderline cases a trial of radiotherapy can be used. If the response is favorable, the treatment may be completed. Previous correct irradiation does not interfere seriously with subsequent laryngectomy.

This series included 156 consecutive cases of proved laryngeal cancer treated by radiotherapy, with 37 per cent five-year cures. More than half of the lesions were inoperable. In 48 cases in which the lesions were too advanced for laryngofissure and for which the only surgical alternative was total laryngectomy, there were 57 per cent five-year cures. The inoperable group yielded 17 per cent cures. Among 58 cases in which the cords were not completely fixed, there were 71 per cent cures.

Two tables.

HOWARD B. LATOURETTE, M.D.  
University of Michigan

#### Irritative Cough Due to Neck Metastases. K. Voigt. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 73: 105-108, May 1950. (In German)

Two cases were observed in which cough appeared to be due to reflex irritation of the afferent fibers of the vagus, secondary to metastatic nodes in the neck. The location of the primary tumor appeared to be of no significance. Often the neck nodes were small to palpation and barely visible to inspection. They were observed, however, to infiltrate the surrounding tissues and particularly the jugular vein, making resection difficult or impossible.



Deep x-ray therapy, to limit of tissue tolerance, appeared to have some beneficial influence at least temporarily. Ethyl urethane is recommended by the author in handling these cases, but apparently was not used in either of these two instances.

[The possibility of reflex cough from neck metastases should be considered as a complication in this type of case.—E. W. S.] E. W. SPACKMAN, M.D.  
Fort Worth, Texas

**Role of Radiology in the Diagnosis and Treatment of Mediastinal Tumors.** Paterno S. Chikiamco and Carmen S. Chikiamco. *J. Philippine M. A.* 26: 193-198, May 1950.

The authors recommend a test of irradiation in tumors of the mediastinum where the possibility of malignancy cannot be ruled out. Two cases of mediastinal tumor, both considered to be lymphosarcoma, treated solely by x-ray therapy, are reported. One patient has remained symptom-free for six years following irradiation.

Four roentgenograms.

**Changes in Carcinoma of the Breast Following Irradiation.** George Lumb. *Brit. J. Surg.* 38: 82-93, July 1950.

The purpose of this report is to describe the structural changes which occur in the malignant tissue of the breast as a result of high-voltage x-ray irradiation. The majority of cases received a total tumor dosage of between 2,000 and 4,000 r administered over a period of twenty to forty days.

Naked eye appearances of the cut surfaces showed, where irradiation changes had taken place, a tendency of the tumor to merge into surrounding structures. Diminution of total breast substance was a common finding, and occasionally marked contraction with virtual disappearance of fat was seen.

The most striking histologic finding was actual disappearance of malignant cells, which may be the result of acute cell dissolution or of alteration of cell structure followed by death. The mechanism of acute cell dissolution seems to be principally by lysis of both nucleus and cytoplasm. The alterations in cell structure consist of pyknosis on the one hand and enlargement of the nucleus with or without vacuolation on the other, vacuolation of the cytoplasm, and a tendency of the cells to run together to form symplasma. Giant cells have been described, either as large cells with a single dense hyperchromatic nucleus or as multinucleated cells. Microscopic amounts of calcium are sometimes found in the nuclei of malignant cells and sometimes in the connective tissue replacing areas of destroyed tumor substance.

Following the disappearance of some of the malignant cells, there occurred a gradual increase of fibroblastic activity, formation of collagen strands, and gradual obliteration of the small vessels. A hyaline substance appeared scattered through the strands of collagen and in areas where accumulations of tumor cells had previously existed. It was also laid down around the walls of ducts involved in the malignant process.

It is suggested that a dosage below 2,000 r is insufficient to produce any significant changes, and as the dose is increased a progressively larger number of cases are affected. In cases receiving a dosage over 3,500 r no unaltered malignant cells could be demonstrated.

The damage to normal tissues when the dose was increased above 4,000 r was excessive.

Thirty-six photographs and photomicrographs, including 7 in color. HOWARD L. STEINBACH, M.D.  
University of California

**Carcinoma of the Endometrium.** Robert A. Kimbrough and Craig W. Muckle. *South. M. J.* 43: 609-614, July 1950.

The authors review the subject of carcinoma of the endometrium with reference to possible etiology, basic pathology, symptomatology, early diagnosis, methods of treatment, and end-results. They then present a series of cases seen in the Pennsylvania Hospital (Philadelphia) from 1937 to 1939.

Possible etiological factors include hyperplasia of the endometrium, prolonged unopposed estrogen stimulation, abnormal uterine bleeding at the menopause, and uterine myomata.

The usual histologic type is adenocarcinoma. The process often remains localized much longer than carcinoma of the cervix. Metastases occur both by lymphatic spread and by the blood stream. The degree of differentiation has an important bearing on the prognosis; the best results have been obtained in the differentiated (Grade I) group, while patients with highly embryonal tumors (Grade IV) rarely survive for a period of five years.

Since most of the patients have passed the menopause, bleeding is the outstanding symptom. Prior to the menopause, metrorrhagia is the characteristic feature. The prognosis is poor in patients who complain of pain.

Diagnosis is suggested by a history of irregular vaginal bleeding, especially in an overweight, nulliparous woman or one who has undergone a radiotherapeutic menopause. Papanicolaou studies of vaginal secretions are useful but the diagnosis should be confirmed by diagnostic curettage.

The greatest salvage is obtained by radiation therapy, either x-rays or radium, followed by surgical removal of the entire uterus and adnexa. At the Pennsylvania Hospital the usual treatment consisted of intra-uterine application of 100 mg. of radium, in units of 25 mg. (1 mm. platinum filtration) for 4,000 mg. hours, followed in four to six weeks by total abdominal hysterectomy and bilateral salpingo-oophorectomy.

The Pennsylvania Hospital series consisted of 95 cases seen from 1937 through 1949. Only 48 of these are evaluated as to five-year end-results. The age range was from 37 to 85 years, with more than four-fifths of the patients above the age of 45. Taylor's modification of Healy's original classification of these lesions (Taylor and Becker: *Surg., Gynec. & Obst.* 84: 129, 1947. *Abst. in Radiology* 50: 141, 1948) was used. On these criteria 40 per cent of the cases were of Group I (uterus size of two-and-a-half-months pregnancy or less). Six cases were of the most advanced class, Group III B. Radiation therapy alone, either radium or x-ray or both, was used in the treatment of two-fifths of the cases, while most of the remainder were treated surgically following irradiation. The total five-year survival rate was 62.5 per cent. For 23 cases treated by radium and subsequent hysterectomy and bilateral salpingo-oophorectomy, the five-year salvage was 91.3 per cent.

Twelve tables. HARVEY J. THOMPSON, JR., M.D.  
Jefferson Medical College



**Carcinoma of the Cervix Associated with Pregnancy.** W. O. Johnson and B. J. Weinfurter. *Am. J. Obst. & Gynec.* **59**: 1189-1198, June 1950.

The question of treatment of carcinoma of the cervix was for many years apparently settled in favor of radiation therapy alone, but now that a plateau of results with this form of treatment has been reached, showing at best less than 50 per cent five-year arrests, the authors feel that the matter should receive further consideration. They believe that a combination of radium, x-ray, and radical surgical removal in Stage I and Stage II cases produces more gratifying results.

From a study of 12 cases seen in the Louisville (Ky.) General Hospital, and from their perusal of the literature, the authors believe that when the diagnosis of carcinoma associated with pregnancy is made, at least three treatment plans are to be considered.

- I. Destroy the lesion.
  - (a) Hysterotomy without curettement.
  - (b) Interstitial and intracavitary radium to 4,500-5,000 mg. hr.
  - (c) Deep x-ray therapy, when indicated by possible metastasis, for a total of 4,000 to 6,000 r.
- II. In exceptional instances, make an attempt to save the child.
  - (a) Start treatment with radium.
  - (b) Await viability.
  - (c) Deliver the child, preferably by Porro section.
  - (d) Give deep x-ray therapy and radium to the local lesion.
- III. Save the child and give palliative therapy to the mother after viability, in late cases where the outlook for cure is hopeless from the beginning.
  - (a) Porro section.
  - (b) Extensive x-ray and radium therapy as indicated, with careful follow-up.
  - (c) Radical surgery if possible, with iliac lymphadenectomy.

The authors recommend that all products of conception be removed by the abdominal route because of the dangers of hemorrhage, infection, and dissemination of the malignant lesion if spontaneous delivery is allowed.

Four photomicrographs; 2 tables.

ROBERT H. LEAMING, M.D.  
Jefferson Medical College

**Beta-Ray Application to the Eye, with the Description of an Applicator Utilizing  $\text{Sr}^{90}$  and Its Clinical Use.** H. L. Friedell, C. I. Thomas, and J. S. Krohmer. *Am. J. Ophth.* **33**: 525-533, April 1950.

Under certain conditions the short range of beta particles in tissue is particularly useful in radiation therapy. This is true in the eye, where it is important to protect the deeper structures, such as the lens, from deleterious radiation effects. No special therapeutic benefit is to be attributed to the beta rays proper. The beneficial effects are the result of ionizing radiation and can be produced as well by x-rays. With the latter, however, it is difficult to prevent injury to the deeper structures.

The criteria for selection of an element for any beta-ray emitter are essentially: (1) that the half life, or rate of decay, be sufficiently long so that replacement or replenishment is at a minimum; (2) that the beta

radiation be unaccompanied by gamma rays, so that the problems of protection of the operator are more easily solved; (3) that the beta rays have sufficient energy so that their range in tissue will be suitable for biologic purposes; (4) that the chemical characteristics of the material be such that it may be manipulated and handled easily when being placed in an applicator.

$\text{Sr}^{90}$  appears to be an ideal element. It has a half life of twenty-five years. It does not emit gamma rays and it is easily handled. It emits two beta particles before decaying to stable zirconium. The first of these is weak and contributes only slightly to the radiation dose. The second is quite energetic and penetrates, on the average, about 30 mm. beneath the surface.

An applicator is described consisting of a lucite capsule enclosed within an aluminum capsule. The strontium is introduced into the lucite capsule in the form of a chloride solution and evaporated by passing warm, dry air over it. The dose emitted is 5.4 equivalent roentgens per second at the surface. The half-value layer of this radiation is 0.9 mm. in tissue. Treatments are given by the direct-contact technic, since only thus can the actual dose to the tissue be adequately regulated.

Clinical applications of the  $\text{Sr}^{90}$  beta-ray applicator have proved satisfactory and compare well with the beta radiation administered with a radon beta ray applicator. The usual diseases of the eye, which include superficial tumors of the lids and conjunctiva, vernal conjunctivitis, anterior segment tuberculosis, vascularization of the cornea, and corneal ulcers, have been treated.

[This material appears also in *Am. J. Roentgenol.* **65**: 232-243, February 1951, with a full color plate depicting parallel exposures with  $\text{Sr}^{90}$  and radon applications.]

Six charts; 1 table.

HOWARD L. STEINBACH, M.D.  
University of California

**Beta Irradiation. An Evaluation of a Radium-D Applicator for Ophthalmic Use.** Fred M. Wilson. *Am. J. Ophth.* **33**: 539-548, April 1950.

The radium-D applicator has three important fundamental qualities to be considered: (1) low photon activity, an advantage, since it assures an almost pure beta ray emission; (2) low-energy beta emission, a disadvantage, since it means a softer, less penetrating beta irradiation; (3) low output, a disadvantage, because it necessitates a prolonged treatment time.

With rabbits as experimental animals, the author compared the effects produced by an applicator containing an amount of radium-D which was calculated to produce approximately a 10 mc. output, with an applicator containing three radon needles which were 7 to 8 mm. long. The active area was about 25 sq. mm. in both applicators. The ratio of radon to radium D for equally effective doses, in the production of corneal lesions, was approximately 2:5, which indicates that the radium D applicator used is about 40 per cent effective on the basis of its millicurie rating as compared with radium needles applied at near contact.

Vascularizing lesions of the cornea constitute one of the most common indications for beta irradiation in ophthalmology, and the beta radiation which has been used in the past, from radon and radium sources, has been practically ineffective in eliminating deep vascularization. The average energy of the beta particles

of radium D is even less and it is, therefore, not the beta source of choice for more deeply placed vessels or any lesions of comparable or greater depth.

Three illustrations; 4 tables.

HOWARD L. STEINBACH, M.D.  
University of California

**Glioma of the Retina in Father and Child.** Joseph Laval. *Arch. Opth.* 44: 140-145, July 1950.

In January 1927, a 2-year-old white boy had his left eye removed because of a glioma of the retina, verified histologically. There was no extension into the optic nerve. He grew up and married, and in February 1948 his wife gave birth to a girl. When the child was six months old, the parents noticed that her right eye was larger than the left. Examination showed the cornea of the right eye to be steamy, the iris discolored, the tension extremely high as determined by palpation, and the globe injected. Examination of the left eye showed almost complete detachment of the retina and yellowish-white masses and new-formed blood vessels. Roentgenologically the chest, skull, and sternum revealed no evidence of metastases. The right eye was enucleated. The histologic diagnosis was glioma. Roentgen therapy to the left eye was started about ten days later. The upper part of the gliomatous mass receded to some degree but began to grow again in a few months. Accordingly, the left eye was enucleated. The total radiation given was as follows: to the anterior field, 3 cm. in diameter, a total of 3,500 r in air, and to the lateral field, 3 X 2.5 cm., 3,200 r in air. The radiation factors were 200 kv., 19 ma., 0.5 mm. copper and 1 mm. aluminum filtration, target-skin distance, 50 cm. Both fields were treated daily, 300 r being divided between them. The estimated tumor dose was 5,300 r; it was considered that the most effective irradiation came through the direct anterior portal. The amount of

irradiation to which this child's eye was exposed was sufficient to destroy a great deal of glioma tissue, but it was also sufficient to cause serious damage to the adnexa, cornea, and the lens. The author believes, therefore, that radiation therapy for retinal glioma should not be undertaken if more than one sixth, or one fourth at the most, of the retina is involved by glioma. He also believes that all survivors of glioma should be warned not to have children.

Five illustrations.

**Eosinophilic Granuloma of the Skin. Report of Cases Representing the Two Different Diseases Described as Eosinophilic Granuloma.** Walter F. Lever and Roy W. Leeper. *Arch. Dermat. & Syph.* 62: 85-96, July 1950.

At present two entirely different cutaneous diseases are known as eosinophilic granuloma. One occurs in young children and is associated with eosinophilic granuloma of the bone. The lesions may appear anywhere on the skin except that they seem to spare the face; they consist of yellowish scaling papules, of yellowish firm plaques which may become eroded, or of irregular undermining ulcers. The lesions are radiosensitive. This condition represents an abortive form of Hand-Schüller-Christian disease. Eosinophilic granuloma of the second type occurs in adults. It is characterized by soft, purplish, slow-growing and asymptomatic patches on the face, covered by normal-appearing epidermis. The lesions do not ulcerate and are radioresistant. The etiology is unknown.

One case of the first type and 2 of the second are reported. Good results were obtained in the first case with roentgen irradiation. On the basis of the 3 cases, the differences in the clinical and histologic picture of the two diseases are discussed.

Three photographs; 7 photomicrographs.

## RADIOISOTOPES

**Significance of Radioisotopes to Radiology.** J. W. J. Carpender. *Wisconsin M. J.* 49: 489-492, June 1950.

The author has reviewed the radioisotopes which have been used in therapy and diagnosis and has estimated their probable future in radiology.

$P^{32}$ , which has a half life of 14.3 days, emits a beta particle which penetrates about 8 mm. of tissue. While  $P^{32}$  may be given by mouth, the method of choice is intravenous injection of a solution of isotonic sodium monohydrogen phosphate. Dosage in the chronic leukemias usually varies from 1 to 3 millicuries, depending on the severity of the disease. Repetition of treatment is governed by response of the peripheral blood cell count and relief of symptoms. In cases in which symptomatic relief is obtained but a high white cell count remains, treatment is suspended. Frequently, x-ray therapy is needed in order to reduce an enlarged spleen or lymph nodes where these have not decreased in size under  $P^{32}$ .

Acute leukemia, Hodgkin's disease, lymphosarcoma, and multiple myelomas, in general, have proved refractory to  $P^{32}$ , but a few reports are favorable. In polycythemia vera, however,  $P^{32}$  has become almost the standard treatment. Dosage is quite different from that used in chronic leukemias. Up to 6 millicuries may be given in a single treatment, but these doses are

not repeated more frequently than every three months.

Iodine was first used by Hertz in the study of thyroid physiology. Because it was almost selectively utilized and stored in the thyroid gland, its diagnostic and therapeutic use was soon attempted. In more than 60 per cent of thyroid carcinoma,  $I^{131}$  will fail, but in cases in which uptake occurs, some spectacular results have been obtained. In cases in which the cells of the tumor are unable to use and store iodine, poor results can be expected. This usually is the situation in papillary adenocarcinoma. Solid alveolar carcinoma shows uptake occasionally, and follicular and alveolar carcinoma shows utilization in over 50 per cent of cases.

The status of irradiation by means of  $I^{131}$  in hyperthyroidism is by no means clear, because not enough time has yet elapsed to allow adequate assaying of the risk of late neoplasm resulting from such irradiation. Because of this potential risk, it is well to employ  $I^{131}$  in only two classes of patients: (1) those who cannot or will not submit to operation and (2) those over sixty years of age, in whom the normal life expectancy is so low that the danger of late neoplastic degeneration is slight. In Graves' disease, fractionated dosage is favored, about 2 to 4 millicuries being given every six weeks to a total of 10 to 12 millicuries, depending on symptoms and the basal metabolism rate. The iodine

is given by mouth as an aqueous solution of inorganic radioiodine containing no normal iodine.

Radiosodium, radioarsenic, manganese, and gold have been used in treatment of diseases of the hematopoietic and lymphatic systems. Their effect is much like that of total body irradiation, and they have the disadvantage, as compared with  $P^{32}$ , of irradiating structures where no radiation is desired. Diagnostically, sodium in tracer amounts has been found useful in peripheral vascular disease.

Radioactive cobalt,  $Co^{60}$ , may be of considerable importance. It is doubted that it will ever replace radium, because of its relatively short half life, 5.3 years, but in some instances it could be most useful. It emits an almost monochromatic gamma radiation, which is a little stronger than that of the average of radium, and a very weak beta particle, so that filtration is not a problem. For needles and certain intracavitary applicators now in process of design, it may be ideal. Even more important could be its use in large sources comparable to the so-called radium bombs. Such installations with sources as great as 400 curies are planned.

A large number of isotopes other than those mentioned have been used as tracer elements in the study of various vital processes. DANIEL WILNER, M.D.  
Atlantic City, N. J.

**What's New in Isotopes, 1950.** R. R. Newell. California Med. 73: 11-15, July 1950.

In this short article, Newell calls attention to some five dozen items in the field of radiobiology which seemed to him novel, important, or scientifically stimulating. A perusal of this annotated review should provide the radiologist with an insight into the far-reaching implications of this branch of his specialty.

DONALD S. CHILDS, JR., M.D.  
The Mayo Clinic

**Evaluation of Radioiodine Test for Thyroid Function.** Henry L. Jaffe and Richard E. Ottoman. J. A. M. A. 143: 515-519, June 10, 1950.

Comparison was made of the radioactive uptake test of thyroid function with the basal metabolic rate and protein-bound blood iodine levels, correlating the results with the complete clinical picture. The  $I^{131}$  uptake test was found to be far more accurate than either of the other two (95 per cent as against 80 per cent for the blood iodine level and 67 per cent for the basal metabolic rate).

There are a few limitations, the most important of which is the previous administration of propylthiouracil, thyroid preparations, or iodine-containing compounds. These will result in lower uptake of the  $I^{131}$  and give a false normal reading if thyrotoxicosis is actually present. Acute thyroiditis gives a low reading while a high reading may be obtained in iodine-deficient children with hypothyroidism.

When these few facts are known and a careful history taken, the  $I^{131}$  uptake would seem to be the procedure of choice in evaluating thyroid function.

Anyone interested in diseases of the thyroid, as well as anyone using radioiodine, should see this article in the original for details.

Three photographs; 1 graph.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Metastatic Adenocarcinoma of the Thyroid with Elevated Basal Metabolism: Radioiodine Studies.** S. J. Weinberg, R. M. Fink, Kay Fink, and G. L. Packer. Ann. Int. Med. 32: 1207-1224, June 1950.

Approximately 15 per cent of thyroid cancers may be expected to accumulate radioactive iodine in some degree (Marinelli, *et al.*: Am. J. Roentgenol. 58: 17, 1947. Abst. in Radiology 50: 722, 1948). The authors studied the radioiodine uptake in a case of thyroid adenocarcinoma, proved by biopsy, with known metastases to the liver. The patient also exhibited evidence of hyperthyroidism, a condition rarely associated with malignant thyroid tumors.

On Oct. 2, 1947, roentgen-ray treatments were instituted twice weekly to thyroid and liver. Over a period of two weeks 1,500 r (in air) were given to the thyroid and 600 r (in air) to the liver. Thereafter the thyroid decreased slightly in size. Dysphonia and dysphagia diminished, although the left vocal cord remained paralyzed. Despite a gradual increase in the size of the liver, the patient was relieved of dyspnea.

On Oct. 16, an oral dose of 1.17 mc. of radioactive iodine was given. On Feb. 24, 1948, at which time the patient's general condition showed little change from the previous status, a second dose of 12 mc. of  $I^{131}$  was administered.

There was evidence of slight concentration of the isotope by the thyroid tumor. A search with a lead-shielded counter tube failed to show any sharp concentrations of activity in small areas outside of the thyroid, though at twenty-four hours a weak maximum could be demonstrated over the third lumbar vertebra. The excretion studies indicated a higher retention of radioiodine than normal. The general pattern of the external measurements and the excretion and biopsy data gave the impression that a large mass of tissue in the abdomen had a slight ability to concentrate iodine but could not retain it as long as the thyroid. The relatively low excretion in the urine—only about 35 per cent of the dose during the first three days—was indicative of hyperthyroid activity or tumor uptake, or both.

Death occurred on April 23, 1948. At autopsy radioactivity could not be demonstrated with a Geiger counter at any point over the body. Gross tissue specimens did not contain enough radioiodine for accurate measurement by the technic employed. The microscopic examination showed solid nests and sheets of small carcinoma cells in the thyroid gland. Dense bands of hyalinized collagenous tissue were seen throughout. These frequently incorporated the compressed thyroid acini whose lumens contained pink colloid material. Most of the radioactivity, as shown by radioautographs, appeared to lie in these bands. In addition to the primary tumor, there were metastases in regional and distant lymph nodes, myocardium, liver, kidneys, adrenal glands, and small and large intestine.

The ability of the thyroid adenocarcinoma to concentrate iodine to a slight degree was suspected on the basis of indirect evidence but was not unequivocally demonstrated in biopsy specimens. It had been planned to continue radioiodine therapy in this patient as a method of controlling the symptoms of thyrotoxicosis and to determine whether the metastases might pick up increasing amounts of the isotope as the amount of normal thyroid tissue decreased. Even if the tumor had developed a marked ability to concentrate iodine, however, it seems improbable that the several kilograms of tumor tissue present in the body

could have been destroyed by radioiodine without dosages so high as to cause serious damage to the kidney or other radiosensitive tissues.

Eighteen illustrations, including 2 radioautographs; 2 tables.

STEPHEN N. TAGER, M.D.  
Urbana, Ill.

**Radioactive Iodine Uptake in the Hypermetabolism of Acromegaly.** E. P. McCullagh, A. Gold, and J. B. R. McKendry. *J. Clin. Endocrinol.* **10**: 687-691, July 1950.

As early as 1897 it was noted that certain manifestations of hyperthyroidism, including tachycardia, goiter, and increased oxygen consumption, were present in some cases of acromegaly. In 1927, Cushing and Davidoff (*Arch. Int. Med.* **39**: 673, 1927), in a study of 100 cases of acromegaly, found that 54 per cent of 72 patients tested had basal metabolic rates above normal. Among the 100 patients there were 25 with goiter, and of these 15 had hypermetabolism. The association of these two conditions was rendered less significant by the fact that in 75 per cent of the cases of hypermetabolism the thyroid was not even palpable.

In the present study, radioactive iodine ( $I^{131}$ ) was administered orally in doses of 100 to 400 microcuries to 7 acromegalic patients in the fasting state. Two hours later, radioactivity was measured at the skin surface over the thyroid with a Geiger counter, and the number of counts obtained was calculated as the percentage of the total in the dose given. The  $I^{131}$  uptake in all 7 cases was found to be low or normal. This finding contrasts with the high radioactive iodine uptake in cases of hyperthyroid metabolism, when measured by the same technic, and is adduced as further evidence for the existence of an extra-thyroidal metabolic stimulus in acromegaly. The probable source of this stimulus is, of course, the pituitary gland.

One chart; 1 table.

**Multiple Myeloma: A Study of 24 Patients Treated with Radioactive Isotopes ( $P^{32}$  and  $Sr^{90}$ ).** John H. Lawrence and Louis R. Wasserman. *Ann. Int. Med.* **33**: 41-55, July 1950.

The treatment of multiple myeloma with artificially radioactive isotopes was first attempted by Lawrence and his associates in 1939, and preliminary results in 11 cases were reported in 1941 and 1942 (*Erf. Tuttle, and Lawrence: Ann. Int. Med.* **15**: 487, 1941. *Abst. in Radiology* **39**: 645, 1942; Low-Beer, Lawrence, and Stone: *Radiology* **39**: 573, 1942). The present series of 24 cases (14 in men and 10 in women) includes those previously reported.

The age of onset of multiple myeloma in this series ranged from 29 to 66 years. Fifteen of the patients were over fifty years old at the onset of the disease. Only 2 patients are still living.

Fifteen patients had received x-ray therapy. Anemia was noted in 11 cases prior to treatment with radioactive isotopes and developed during treatment in 10 others. Leukopenia was noted in 4 cases, when first seen, and in 3 additional cases there was a marked fall in the white blood cell count during treatment with  $P^{32}$ .

Of the 21 patients who were treated with radioactive isotopes, 9 received combined  $P^{32}$  and  $Sr^{90}$ , 11 were treated with  $P^{32}$  alone, and 1 received only colloidal radioactive yttrium ( $Y^{90}$ ).

Seven of the patients were not definitely benefited by treatment with  $P^{32}$  or  $Sr^{90}$  or both, but 5 of these had far-advanced disease when first seen. In 8 other cases the benefit from treatment with radioactive isotopes was rather questionable. In 5 patients the results were "relatively satisfactory."

When radioactive phosphorus was first used, large single doses at intervals of two to three days were tried in order to build up a high radiation level. Later, smaller doses were given weekly or biweekly. No precise line of treatment can be recommended at present. The dosage must be individualized and continuous attention must be directed to the state of the hematopoietic system. One millicurie of  $P^{32}$  intravenously once or twice a week for four to six weeks, or about 5 to 10 mc. per course, is suggested. After three to four months, if the blood picture is satisfactory, more radiophosphorus may be given, if indicated.

No evidence that the combination of  $Sr^{90}$  and  $P^{32}$  was more effective than  $P^{32}$  alone was demonstrable.

The results of treatment of multiple myeloma with radioactive elements were not markedly better than those obtained with x-ray or stilbamidine. It is not certain that the course of the disease is influenced by any type of radiation, but symptomatic improvement was sometimes striking.

It seems unlikely that radiostrontium will be a valuable therapeutic agent because of its selective deposition and long half life (fifty-five days). As in the case of  $P^{32}$ , the bone marrow is constantly being irradiated during this period. Thus, an amount of radiostrontium sufficient to destroy tumor cells would produce damaging effects on the normal marrow components before destruction of the neoplastic lesions could be achieved. It is suggested that combination therapy with  $P^{32}$  or  $Sr^{90}$ , the diamidine compounds, and urethane might be a worth-while approach to the treatment of multiple myeloma; also that radioactive stilbamidine may be of therapeutic value due to its combined chemotherapeutic and possible selective irradiation effects.

The average length of life after the onset of the disease in this group of patients was approximately three years.

Three tables.

STEPHEN N. TAGER, M.D.  
Urbana, Ill.

**Accidental Skin Ulcerations from Radioisotopes. Recognition, Prevention and Treatment.** Henry S. Patton and R. Gordon Millar. *J. A. M. A.* **143**: 554-555, June 10, 1950.

A small part of a 0.2 c.c. dose of a (colloidal suspension) radioactive yttrium chloride,  $Y^{90}$ , was deposited accidentally in the perivascular tissues of the forearm of a patient being treated for chronic lymphatic leukemia. A reaction appeared within forty-eight hours, which soon became ulcerated. Excision had to be done three times, and skin grafting performed before healing took place. It was estimated that over a period of eight weeks 100,000 r of beta radiation acted on approximately 1 c.c. of tissue at the level of the cubital vein.

It is strongly urged that, when such material is to be used, an intravenous drip be in operation before introduction of the active agent, preferably with a large needle. If there is doubt about perivascular injection the area should be scanned with a Geiger counter.

Two photographs.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.



**Passage of Radioactive Erythrocytes from the Peritoneal Cavity into the Blood Stream During Experimental Ascites.** Frank W. McKee and Wellington B. Stewart. *J. Exper. Med.* 91: 599-605, June 1, 1950.

Peritoneal absorption of intact red blood cells has been recognized for many years. The cells probably pass through the stomata in the peritoneum, enter lymphatics, and pass through the thoracic lymph nodes without significant phagocytosis.

Experimental ascites produced in dogs by constricting the inferior vena cava above the diaphragm has been a useful method of studying ascitic fluid production. It has been shown that ascitic fluid protein enters the blood plasma from the peritoneal cavity. In this paper the authors attempt to determine whether red cells, as well as protein, pass out from the peritoneal cavity of these dogs. Red cells with radioactive iron incorporated into the hemoglobin make a convenient tool for this type of study.

The experiments, described in detail, indicate that such tagged red cells rapidly cross peritoneal and endothelial barriers and enter the circulating blood in the ascitic dog. A similar experiment in normal dogs showed that the tagged red blood cells entered the circulating blood more rapidly.

One graph; 1 table.

DONALD S. CHILDS, JR., M.D.  
The Mayo Clinic

**Use of Radioactive Phosphorus in Studies of Chick Embryo Infections with a Common Cold Virus.** Thomas G. Ward. *Am. J. Hyg.* 52: 107-132, July 1950.

Investigations concerning the nature of the etiological agent of the common cold are hampered by lack of a method for indicating the presence of the virus in suspected material. In view of the lack of success with immunological and biochemical methods, the author decided to investigate radiochemical procedures in an attempt to develop a technic for detecting the presence of a common cold virus in the chick embryo. The description of the method and discussion of its interpretations are highly technical and should be read in the original. The author tentatively proposes this radiochemical procedure as a practical laboratory method for the study of viruses in the chick embryo.

Two graphs; 14 tables.

DONALD S. CHILDS, JR., M.D.  
The Mayo Clinic

**An Apparatus for Pipetting Radioactive Solutions.** A. F. Graham. *J. Lab. & Clin. Med.* 36: 146-147, July 1950.

A device which has been useful for the accurate and safe pipetting of tracer amounts of radioactive solutions is illustrated and described.

HOWARD L. STEINBACH, M.D.  
University of California

## EFFECTS OF RADIATION

**Anuria Following Radiation Therapy in Leukemia.** Harold Lear and Gordon D. Oppenheimer. *J. A. M. A.* 143: 806-807, July 1, 1950.

A case is reported in which anuria was caused by uric acid crystals mechanically blocking both ureters. The tremendous increase in uric acid metabolism followed a course of 100 r in air of total body radiation given in twelve days, releasing large amounts of nucleoprotein as the white blood cell count dropped from 475,000 to 45,000 in two months time.

Although the anuria was relieved by indwelling ureteral catheters, the patient died on the fourteenth day of severe renal sepsis resistant to all therapy. Autopsy was not permitted and preliminary renal function and uric acid studies had not been made, but it seems likely that some impairment of kidney function may have been present before the therapy was given. The authors believe that if proper precautions had been taken the complication might have been avoided. They suggest, in addition to careful studies of the patient's urologic status and uric acid metabolism before and during treatment, radiation in divided and spaced doses, forcing of fluids, alkalinization of the urine, and a low-purine diet.

No other case of anuria following radiotherapy was found in the authors' search of the literature, but it seems possible that some have occurred and terminated fatally without recognition. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Acute Thermal, Chemical, Electrical and Radiation Injuries.** Charles G. Neumann. *S. Clin. North America* 30: 563-575, April 1950.

The author begins with a comprehensive consideration of thermal burns, including local tissue damage, systemic effects, complications, and treatment. Chemi-

cal and electrical burns produce similar tissue damage but radiation burns create a somewhat different problem: atrophy of the epithelium, loss of cutaneous appendages, replacement of normal collagen by dense hyalin collagen rich in elastic fibers and poor in cells, and obliteration of the blood vessels of corium and subcutaneous tissue. The reparative proliferation of epidermis in response to the necrosis of corium often results in cancer.

Control of pain in the treatment of severe radiation burns is the first requisite. Care of the wound must be meticulous; it should be sealed with lanolin which has not been autoclaved, applied by cotton dressings without pressure, and after a sufficient interval to allow definite demarcation, should be treated by wide surgical excision and split thickness grafts. Pedicled grafts are often necessary. Even in the absence of ulceration, the use of split-thickness grafting is recommended because of the ever present danger of malignant change.

ALTON S. HANSEN, M.D.  
Peoria, Ill.

**Resin of Podophyllum in Treatment of Cancerous and Precancerous Conditions of Skin. Effect on Basal Cell Epithelioma and Seborrheic, Senile and Radiation Keratoses.** Leslie M. Smith and H. D. Garrett. *Arch. Dermat. & Syph.* 61: 946-953, June 1950.

A series of cases is reported of basal-cell epithelioma and seborrheic, senile, actinic, and roentgen-ray keratoses treated with resin of podophyllum applied locally. Although the longest period of observation has been less than a year, the results were so good that the authors felt justified in making a preliminary report.

At present, a daily application of 15 per cent resin of podophyllum in compound tincture of benzoin is used. The substance is allowed to dry and is then covered with

gauze. Before each reapplication the necrotic slough must be removed by gentle curettage or wiped away with gauze. The adjacent skin becomes inflamed and macerated and desquamates, but the action on the normal skin is not deep. The growth rapidly sloughs out in successive layers, and one can easily determine the borders between normal tissue and the thicker and deeper epithelial lesion. Patients are warned to be extremely careful not to tamper with the dressing for fear of transferring minute quantities of resin of podophyllum to the eye. The average length of treatment in the 2 cases of roentgen keratoses treated in this manner was eight days; healing occurred in twenty-one days.

The microscopic changes occurring during treatment are described.

Six photographs; 2 photomicrographs.

**Protecting Photofluorographic Personnel From Excessive Radiation.** Willard W. Van Allen. Public Health Rep. 65: 865-868, July 7, 1950.

Radiation hazards in photofluorography are present to a greater extent than in other roentgenographic diagnostic procedures.

The quantity of radiation required for a photofluorographic exposure is several times that used for a conventional roentgenogram. It is not unusual to have over five hundred (500) exposures per day, for many consecutive days. Most units are portable or mounted in trucks, and operating space is limited, which creates additional protection problems.

Radiation monitoring revealed that frequently technicians were receiving in excess of 300 milliroentgens per week. Improvement was made in only a short time by conscientious observation of safety rules by personnel, so that the majority of technicians succeeded in reducing their dosage considerably.

A study of radiation fields was made and serves to show by isodose curves where radiation hazards exist and ways of avoiding excessive exposure.

[A paper by the author on "Secondary Radiation Fields Surrounding Photofluorographic Equipment" is to appear in the June issue of RADIOLOGY.—Ed.]

Two charts.

EDSEL S. REED, M.D.

Louisville, Ky.

**Tracer Iron Distribution Studies in Irradiated Rats with Lead-Shielded Spleens.** R. L. Huff, W. F. Bethard, J. F. Garcia, B. M. Roberts, L. O. Jacobson, and J. H. Lawrence. J. Lab. & Clin. Med. 36: 40-51, July 1950.

The development of ectopic erythropoiesis in the lead-protected spleens of mice after whole body exposure to x-radiation has previously been demonstrated (Jacobson *et al.*: J. Lab. & Clin. Med. 35: 746, 1950. Abst. in Radiology 56: 635, 1951). Within a few hours after whole body irradiation, increased erythropoietic activity could be observed microscopically in the protected spleens, whereas in the spleens without lead protection the usual massive destruction and atrophy were seen. Animals of the former group failed to show the marked anemia which occurred after approximately ten days in the totally irradiated group. In view of these observations the extent of such extramedullary erythropoiesis was investigated by means of radioiron time-distribution studies.

A serial distribution study after a single intravenous

injection of  $\text{Fe}^{59}$  was carried out in rats three days after 500 r whole-body x-irradiation. Half of the rats were irradiated with their spleens exteriorized and protected. The animals having protected spleens showed a time-concentration relationship of tracer iron in the spleen which was almost identical to that of the bone marrow of control animals. This was not true of those animals which received the same amount of irradiation without spleen protection.

The red cells of the spleen-protected animals showed a significant concentration of tracer iron in contrast with those of the non-protected animals.

The livers of the irradiated, non-protected animals accumulated four times as much tracer iron as the controls, but the spleen-protected animals accumulated only three times as much.

The bone marrow of the non-protected animals contained very little  $\text{Fe}^{59}$  at any time; yet the animals with protected spleens demonstrated the capacity to accumulate the tracer in their marrow.

Six charts; 2 tables.

HOWARD L. STEINBACH, M.D.  
University of California

**Atrophy of the Gastric Glands Produced by Beta Rays. Histologic Findings in Animals.** D. M. Douglas, W. R. Ghent, and S. Rowlands. Lancet 1: 1035-1038, June 3, 1950.

The authors report an investigation of the possibility of producing atrophy of the gastric glands by beta irradiation, thus reducing the secretory activity of the stomach without affecting its function as a reservoir.

Four dogs were used for the study. The intragastric source of beta rays consisted of three balloons firmly attached to a 16 F stomach tube. Between the inner and middle balloons a mixture of 75 millicuries of  $\text{P}^{32}$  with latex was distributed as evenly as possible. When the inner balloon was inflated, the whole assembly assumed the shape of the stomach and lay in contact with the mucosa. The dosage-rate was calculated approximately from the activity of the balloon and its surface area when in the stomach. The time of irradiation was then adjusted to give an average dose of 5,000 r to the gastric mucosa of each dog (five to nine hours). Under these conditions the first few millimeters of tissue probably received a dose of 20,000-25,000 r. From thirty-nine to seventy-four days after the beta irradiation, biopsy specimens were taken from the stomach. All 4 dogs showed atrophy of the tubular glands of the stomach, though in different degrees. The underlying submucosa and muscularis were histologically normal.

The authors hope that, if the method described here will produce hypochlorhydria safely and consistently in animals, it may prove useful in the non-operative management of duodenal ulcer in man.

Eight figures, including one roentgenogram.

**Effect of Low-Voltage Roentgen Rays on the Normal and Vascularized Cornea of the Rabbit. A Preliminary Report on the Philips Machine.** Harold G. Scheie, Richard H. Dennis, Richard C. Ripple, Larry L. Calkins, and John A. Buesseler. Am. J. Ophth. 33: 549-570, April 1950.

The experimental work presented in this paper, from the University of Pennsylvania, concerns the effect of low-voltage roentgen radiation from the Philips apparatus (44 kv.) upon the normal rabbit eye, as well as

observations upon the inhibitory effect of such rays upon experimentally induced corneal vascularization.

Experiments upon the normal eye of the rabbit demonstrated that, if the irradiated area included the cornea, adjacent conjunctiva, and sclera, dosages up to 2,000 r could be given weekly for as long as five weeks with no apparent ill effect in the cornea or lens. When the exposure was limited to the center of the cornea through a 5-mm. portal, dosages up to 5,000 r weekly for as long as twenty-one weeks caused no permanent damage. Production of cataracts was observed only twice. This occurred in animals which received 5,000 r and 10,000 r respectively, weekly for twenty-one weeks. The longest period of observation, however, was fourteen months.

In observations of the effect of low-voltage x-rays upon experimentally induced corneal vascularization as produced by the local injection of sodium hydroxide, it was found that if the eye was irradiated at the time of the sodium hydroxide injection, the results were indecisive, although the smaller doses of 750 r and 1,000 r slightly inhibited the ingrowth of vessels into the lesion. If, however, the irradiation was begun after the ingrowth of new vessels had already become established, there was marked inhibition of vascularization. Doses of 750 r and 1,000 r at weekly intervals were effective. Daily doses of 300 r to 1,000 r were more effective than exposures given at longer intervals. Exposures of 300 r when given daily were as effective as exposures of 1,000 r.

Exposures of 400 r and 500 r repeated three and four times at approximately four-week intervals have been used clinically in several hundred patients without evidence of cataract formation. These patients have been observed for as long as two and one-half years following treatment.

Eleven figures; 5 tables.

HOWARD L. STEINBACH, M.D.  
University of California

**Medical Aspects of the Effects of Atomic Explosion.**  
J. N. B. Crawford. *Canad. M. A. J.* 62: 529-534, June 1950.

When an atomic bomb explodes, vast quantities of radiant energy are released, and thermal injuries are produced in two ways—flash or ray burns, produced by the action of radiant energy; flame burns, produced by secondary fires. Flash burns are profile burns affecting only that surface of the skin which is directly exposed to the ray. Among the Japanese these burns were usually followed by keloid formations. It has been reasonably estimated that burns of one kind or another caused 20 to 30 per cent of the deaths in the Japanese bombings.

The effects produced by radiation injury have caught the popular fancy and have been much publicized. Actually, from the point of view of casualty production

this effect of the atomic bomb is the least important. Stafford Warren estimated that radiation injury in Japan was responsible for 8 per cent of the deaths. Other medical investigators who spent time in that area feel that 15 to 20 per cent is nearer the truth.

When an atomic bomb explodes, ionizing radiation is instantaneously produced. This is in the form of alpha and beta particles, slow and fast neutrons, x-rays, and gamma rays. The alpha and beta rays, because of their small range and low penetration, do not form a serious hazard if they come from an external source. If, however, radioactive particles are taken into the body by inhalation or ingestion, they tend to be concentrated in the bones, and under these circumstances alpha particles emitted have a damaging effect on bone marrow. Neutrons and gamma rays have a great range and a high power of penetration. They will render radioactive many familiar elements such as sodium or carbon, against which they impinge.

When the bomb explodes, many fission products are carried upward in the "atomic cloud" by the heat that is produced and are dispersed by the wind. They gradually settle over large areas and emit radioactivity. These products are hazardous only if they are concentrated in a contaminated area. Secondary radioactivity also must be considered, but such radioactivity from ground and normal structural materials will have decreased to below the dangerous level within two minutes of the instant of explosion.

Consideration of the clinical effects of atomic explosions reveals that epilation is common among persons who survive more than two weeks and occurs on the thirteenth to fourteenth day after exposure. In no case reported has epilation been permanent.

Vomiting is a common early symptom and occurs as early as thirty minutes after exposure. Diarrhea is common within the first few days. Radiation effects are discernible in the testis as early as the fourth day and are profound in all fatal cases within 1,500 meters of the bomb. The ovaries show a less striking change. Amenorrhea is common for three to four months following the bombing, but is not permanent. The lymphoid and hemopoietic tissues undergo rapid necrosis. Hemorrhage is a common finding not only in the skin but in the internal organs.

Diagnosis of radiation illness can be made by clinical examination but this is a time-consuming process, and a superior method would be to rely on a film badge or pocket dosimeter.

Treatment is non-specific and is chiefly supportive in nature. Rest, good nursing, antibiotics, concentrated plasma, and whole blood transfusions are the most useful measures in the treatment of radiation sickness.

[See the Symposium on "Radiologic Defense in this issue of radiology, pp. 639-683.]

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